TOPICS OF THE MONTH

Fuels of the future

THE latest manifestations of the competition between nations to develop newer, faster and more destructive missiles with which to frighten each other, along with ambitious ideas for conquering outer space (ironically sharpened by a latent yearning to get away from it all !) bring into prominence the advance of chemical synthetic fuels as the successor of hydrocarbon fuels for missiles, piloted aircraft and, later, as production costs are brought down, for commercial development. Let there be no mistake that this is going to be one of the world's major industries, bringing a wealth of increased scope for chemists and engineers.

The latest gift of chemical technology to military might is high-energy fuels, now brought into semi-commercial production by Olin Mathieson Chemical Corporation in the United States and destined to become a $1,000-million industry within the next 10 years. Here, boron comes into its own as a base for jet propellants, although some strong claims are also made for lithium, a good second, but giving less B.Th.U./lb. value—an important point where this type of fuel is concerned.

The beginning of large-scale production of boron fuels marks the culmination of much effort to overcome the problem of combining boron and hydrogen, and other ' alloying ' elements, in proportions to give the optimum combination of high B.Th.U./lb., safe handling characteristics and economy of manufacture. In general, the manufacture of ' HEF ' fuels consists of treating boron-containing ores in such a manner that they are converted to useful intermediate boron compounds. Subsequent reactions of these intermediates convert them to the final product.

The entire operation is a completely integrated process requiring only the starting boron chemicals and a small amount of other materials. By-products of certain steps in the process are recycled in such a manner that they are used as reactants in some earlier processing steps.

Olin Mathieson's next immediate concern is the construction of a $36-million plant, sponsored by the U.S. Air Force, expected to come into operation within the next 20 months. While the Olin Mathieson plant at Niagara Falls is the first plant in the U.S. in semi-commercial production of high-energy fuels, they are not the only company concerned in this field, for at Muskogee, Oklahoma, Callery Chemical Co. has begun construction of a $38-million plant for the U.S. Navy.

However, it is not all high-energy fuels in the world of jet propellants and in a contribution to a recent *Financial Times* survey Sir Alwyn Crow, C.B.E., pointed out that, by and large, as far as civilian application is concerned, interest is at the moment mainly centred on the use of concentrated hydrogen peroxide, either as an oxidant in conjunction with another fuel or as a mono-propellant. The same authority points out that the new chemical fuels industry can be expected to expand into one of the most important of economic fields, particularly in view of failing resources of coal, oil and natural gas.

The trend seems to be confirmed in the news that world-wide demand for aircraft jet fuel, according to the Caltex group of companies, is now higher than that for aviation gasoline. A sharp increase in the use of jet fuels and a decline in the use of aviation gasoline is also being predicted.

It should not be overlooked that the production and further development of chemical fuels of all kinds is bound to lead to the releasing of a great many subsidiary and kindred products which should make a significant impact on the pattern of world chemical production.

Atomic energy and South Africa

IN this issue we bring into focus some recent happenings in the field of atomic energy, with articles giving special attention to the latest technological advances of the United Kingdom Atomic Energy Authority, the use of radiation techniques in the coal industry and the contribution of ion exchange to nuclear technology.

There is no doubt about Britain's continued lead in bringing the peaceful uses of the atom to fruition and a promising recent event is the signing of an agreement with the South African atomic energy organisation for co-operation between the two countries. It is clear from recent developments, described in our associate journal *Atomics* for July, that South Africa is now making a determined effort to make up the leeway she has lost in atomic energy. The recently formed commission on nuclear power in South Africa has held its first meeting and is to study the establishment of a nuclear power station or stations in certain areas remote from coalfields. A mission which went overseas in 1954 to study developments in the use of atomic power for peaceful purposes reported that, because of the low price of coal in the Union, it was cheaper to generate electricity from coal than from atomic power—even in Cape Town, which is about 1,000 miles from the coalfields. On the other hand, an atomic power station in the Cape would mean a big easing of transport difficulties, while a reactor in the Union would provide local physicists with opportunities for study. South African scientists who went overseas to study nuclear physics did not want to return to the Union because of lack of opportunities in the nuclear field there.

South Africa's uranium ore reserves are 1,100 million tons and there is clearly an incentive in such a rich source of raw materials to develop the use of nuclear energy within the Union.

Interest in carbon black

INTEREST in starting carbon black production units in countries under American licensing agreements is reported to be growing. Two U.S. concerns are already operating plants in Britain—United Carbon Co. with £50 million p.a. capacity, and Godfrey L. Cabot Inc. with £11 million p.a. A third operated by the British firm, Philblacks Ltd., was reported to be paying process royalties to the Phillips Petroleum Co. Cabot is to open a £40 million plant in France on October 15. Cabot also operates a plant in Canada and in Australia, and is reportedly planning a joint £30 million venture with United Carbon.

The Columbian Carbon Co. and Celanese Corporation of America are now building a plant in Brazil which is to open in 1958. Argentina, Venezuela, Mexico, Italy, Japan, India and other countries would like to have such plants opened, industrial circles report.

U.S. carbon black exports last year were 425 million lb. worth $36 million, against a 1955 total of 453 million lb. worth $40,600,000.

Vessels for cryogenic engineering

IN low-temperature processing (as in the liquefying of gases and separation of their components) can be seen an important and rapidly developing field that will make a considerable call on chemical engineering knowledge. Among the more recent developments are new techniques of separating gas mixtures by distillation after liquefaction, a new method for the large-scale liquefying of helium, and elimination of the serious trouble that the pressurising gas, nitrogen, causes in rockets by becoming mixed in with the liquid oxygen propellant.

As we go to press the Cryogenic Engineering Conference is being held at Boulder, Colorado, U.S., and these and many other topics will be examined by engineers and physicists concerned with this field. Host to the conference is the National Bureau of Standards whose Cryogenic Engineering Laboratory at Boulder is engaged in the development of cryogenic techniques and the obtaining of engineering data.

One of the most important problems in low-temperature technology is that of keeping heat out of low-temperature equipment. The problem of thermal isolation from the external surroundings was largely solved by Sir James Dewar, who contributed one of the most important inventions to cryogenic technique —the vacuum-jacketed container, with walls of high reflectivity for rejecting thermal radiation.

For large-scale apparatus, investigation has indicated that evacuated powders such as *Perlite*, diamataceous earth, and silica aerogel provide a decided improvement over the standard vacuum-walled low-emissivity Dewar vessel. In addition, the evacuated-powder insulated vessel can have high-emissivity walls and a thousand times greater gas pressure without destroying its usefulness as an efficient low-temperature vessel.

At present, single-component evacuated powders find their principal commercial application in vessels for large-scale storage and transportation of liquid oxygen. A further step has been the construction of a powder-insulated vessel for truck transportation and short-time storage of liquid hydrogen, the first large-scale liquid hydrogen vessel that does not require use of a thermal shield cooled by an auxiliary refrigerant such as liquid nitrogen. The superior performance of the metal powder mixtures permits extensions of these applications and should encourage the use of this insulating principle in other applications requiring efficient insulation. Possible fields of application are gas liquefaction and rectification and low-temperature chemical processes.

Anti-corrosion campaign is on

CORROSION science has made considerable strides in recent years, as the importance of the subject has been more fully realised. In Britain several research associations have made valuable contributions, while praise is also due to the educational work of the Corrosion Group of the Society of Chemical Industry. Government research laboratories such as those of the Ministry of Supply and the Admiralty, the Department of Scientific and Industrial Research, and a number of other research organisations have also played a major part. In other countries, specialist associations and government research bodies have made available much new information on corrosion. The question arises, are these technical advances being translated into action? Is this research information being used to reduce corrosion losses in industry and elsewhere?

To a large extent it is. New products are coming on to the market and new processes are being brought into use. New corrosion inhibitors, de-rusters, corrosion-resistant materials and improved surface coatings are making an appearance. Techniques such as cathodic protection are meeting with wide success. However, a suspicion remains that industry as a whole is not fully awake to the number and variety of anti-corrosion products now available to it. Were all these new products and methods fully used by all sections of industry, corrosion losses could be reduced considerably.

These facts were pointed out at a recent conference in London by Mr. W. G. Norris, managing director of the Leonard Hill Technical Group, who recalled that it was with such thoughts in mind that Leonard Hill in March 1954 launched the first British journal of its kind, *Corrosion Technology*. The immediate success of this journal showed that a real need had existed for a link between corrosion research and its practical application in industry. This success prompted the acceptance of the suggestion that a bigger programme to spread the anti-corrosion gospel should be undertaken.

Mr. Norris then went on to introduce the subject of the National Anti-Corrosion Week, which is being planned by *Corrosion Technology* from October 14 to 19. This, as has been noted previously in these columns,

includes two chief events: a convention and an exhibition. On October 15 and 16, at the Central Hall, Westminster, a dozen scientific and technical papers will be presented and discussed, and many of the subjects will be of direct interest to chemical engineers. Thus, one paper will be by Dr. H. B. Footner (Shell Petroleum Co. Ltd.) on ' Protection of Plant and Equipment in the Petroleum and Chemical Industries.' Another one, by Mr. J. B. Cotton (I.C.I. Ltd.) will deal with ' Corrosion-Resistant Metals and Alloys,' while W. E. Martin (BX Plastics) will speak on ' Vinyl Resins in the Construction of Chemical Plant.'

Corrosion and the chemical engineer

AS a contribution to the campaign against corrosion, referred to in the foregoing item, CHEMICAL & PROCESS ENGINEERING next month will make a special feature of corrosion matters of special interest to chemical engineers. Thus, Dr. G. L. Miller, PH.D., B.SC., A.R.I.C., M.I.CHEM.E., M.INST.M.M., writes for us on zirconium and tantalum as materials of construction for chemical plant, touching also on economic considerations. Mr. C. L. Wilson, B.SC., contributes on the subject of cathodic protection for the chemical industry and includes some useful practical points. Mr. E. W. Jackson, A.M.C.T., A.M.I.CHEM.E., brings together some interesting facts concerning aluminium as a material of construction where water is handled, and there will be other articles too, each dealing with a particular corrosion problem or material of construction. In addition there will be a preview of the Corrosion Exhibition. This special survey of corrosion developments will be in addition to our usual variety of articles, news and features.

New cyclone dust separator

A NEW type of cyclone dust separator has been developed in India in an attempt to overcome several shortcomings of the conventional cyclonic separator. Among these shortcomings is the fact that the flow of gas to be cleaned within the separator is made, due to the conical shape, to change its direction suddenly at a point where its velocity is nearly maximum, if viewed along its radius, and near the region where it is required to deposit its impurities. The result is that the gas, in the course of suddenly changing its direction, has a tendency to pick up those particles which have actually been separated immediately before, and this tendency interferes with the desired separating operation.

Another drawback is pressure drop, while yet another is that the exit tube, usually of metallic material, protrudes inside the body of the separator, with the result that, in the application of the separator to thermal power plants, especially gas turbines, operating on fuel of high residue content, this part becomes unduly heated and is thus rendered liable to deformation or cracking.

The principal object of the new separator is to obviate the above-mentioned drawbacks and to provide an improved construction which tends to avoid the recirculation of particles which have already been separated from the gas at an earlier stage of the operation and thus to ensure a supply of practically clean gas at the outlet of the separator.

Another object of the design is to avoid considerable pressure losses of the air of gas stream. A still further object is to provide a construction which is simple to manufacture from heat-resisting materials and which can be cooled easily.

The new separator design is based on the cyclonic principle. The suspended particles, separated from the gas, are led into a region of small circumferential gas velocity, *i.e.* towards the periphery or outer wall of the cylindrical body of the separator by centrifugal action, assisted by an insertion member provided inside the body of the separator and arranged to cause the clean gases or air to escape through an outlet provided in the cover of the separator. The insertion member is of conical or curved shape appearing convex when viewed from the interior of the separator body, with straight or curved sides, pointing or directed upwards towards the outlet, and a lower portion of the insertion member extending along but spaced from the opposite portion of the outer wall of the separator. Between the outer wall of the separator and the insertion member a narrow annular passage exists through which the separated particles pass to their space of deposition.

This new development was described by Dr. H. A. Havemann and Mr. B. S. Bhaktavatsala Naidu, of the Indian Institute of Science, Bangalore, in the Institute's *Journal*.

Chemical and engineering discoveries in Britain

THE latest annual report of the Department of Scientific and Industrial Research (H.M.S.O., 9s. 6d.) deserves special notice as being the first to appear since the passing of the new Act of Parliament relating to the Department and the subsequent change in its administrative and financial arrangements. It is also the last to include a report from the Advisory Council, which has now ceased to exist and which is replaced by a new body with power to act as well as to advise. However it is hardly to be expected that the report should reveal any sudden change in the trend of research. Indeed, the general pattern is much the same as in previous reports with brief factual summaries of the work carried out by the D.S.I.R. research establishments and the various research associations who co-operate in their particular fields.

One field in which the sense of urgency is greater than in many of the others is fuel research, which is of great importance to Britain, as in Europe generally. The report reveals that work still proceeds apace on the Fischer-Tropsch process for the synthesis of oils and chemicals from coal and there is growing evidence that the slurry technique, in which the catalyst is suspended in a heavy oil through which the synthesis gas is bubbled, may be the most efficient and economical method of carrying out the synthesis. A 50-gal./day pilot plant has been converted for operation

in this way. Another line of thought is that the Fischer-Tropsch synthesis might be affected by gamma radiation from radioactive fission material, and experiments have been started on this.

Of more immediate economic importance perhaps is finding a way to gasify coal and coke fines so that they can be used instead of the scarcer and more valuable coals. Work is now in hand to explore the possibility of gasifying finely divided fuel by injecting it with air or oxygen through the tuyeres of a gas producer containing large coke and working at a temperature sufficiently high for the ash to be removable in a molten condition as slag. Finely divided fuel injected with the blast into the slagging zone should be gasified rapidly to provide the main source of gas, the large coke playing the part of a supplementary fuel with the function of enclosing a hot zone for the gasification of the fines.

At the Chemical Research Laboratory, further work has been carried out, among other things, on the separation of the individual rare earths by ion-exchange methods. Considerable effort is also being devoted to the purification of metals, especially those of interest in semi-conductor work. Radioactive tracers were used in work on mercury and it has been revealed that by comparatively simple means many of the impurities in commercial mercury may be reduced to less than one part in 10^8. The method consists in first thoroughly shaking the mercury with 10% nitric acid and then distilling under reduced pressure. Highly pure mercury is in demand in several fields and these results are therefore of considerable practical interest.

Venting for explosions

THE provision of relief vents in industrial plant is one way of restricting the damage which may follow explosions of gases in the plant. However, there are not enough data available as yet to allow the size and siting of these vents to be calculated satisfactorily, particularly for systems of ducts. Tests have been carried out on the venting requirements of pentane-air explosions taking place in tubes of steel or *Perspex*, the vents being essentially circular orifices mounted in flanges at the ends of the tubes. With open vents, the maximum pressure obtained when the vent was near the source of ignition was between one-half and one-fifth of those obtained when ignition took place at the opposite end of the tube from the vent. When the vents were closed by bursting discs, the maximum pressure was in most tests somewhat higher than the static bursting pressure of the disc and was inversely proportional to the diameter of the vent.

If a cutter, in the shape of a cross, were mounted so that it just touched the centre of either an aluminium or a brown paper disc, the bursting of the disc took place at a lower pressure and as a result the maximum pressure reached in the explosion was reduced to one-third of the value obtained without the cutter. The cutter had little effect when used with a polythene disc. The presence of a vent in the tube often brought about a large increase in the flame speed relative to the tube. This was particularly marked if a disc were burst at a high pressure and as a result the flame was ejected through the vent.

These interesting and useful experiments have been summarised in the latest report of the D.S.I.R. on fire research (H.M.S.O., 4s.) which surveys the progress made in overcoming fire risks in industry and in the home. Among other subjects discussed are flame arresters, dust explosions, fire-fighting apparatus, static electricity and heat-sensitive fire detectors.

Flash cooling

FLASH, or vacuum, cooling seems to be gaining ground as an alternative to the use of brine or other cooling media in the chemical, food and other industries. Flash cooling is based on the principle that sensible heat is removed from a solution to evaporate water from that solution. The construction of the apparatus determines how closely and how quickly the temperature corresponding with the vapour pressure is approached. If a charge is allowed to cool in bulk, this will take much longer—especially if the fluid has a high viscosity—than in the case of a solution which is allowed to flow along a wall in a thin film. In the latter case the hydrostatic pressure is at a minimum, while the evaporating surface is large, so that the fluid attains the temperature equilibrium practically spontaneously.

With flash cooling in bulk, use is sometimes made of a circulation pump, in which case the solution is introduced at the top of the tank and cascaded over the interior parts. This method, however, is not so effective as the continuous-flow vacuum cooler arrangement, which is generally preferred. In some cases, *e.g.* with vacuum crystallisers, the suspension must be subjected to a fixed cooling programme, which is achieved by accurate regulation of the vacuum.

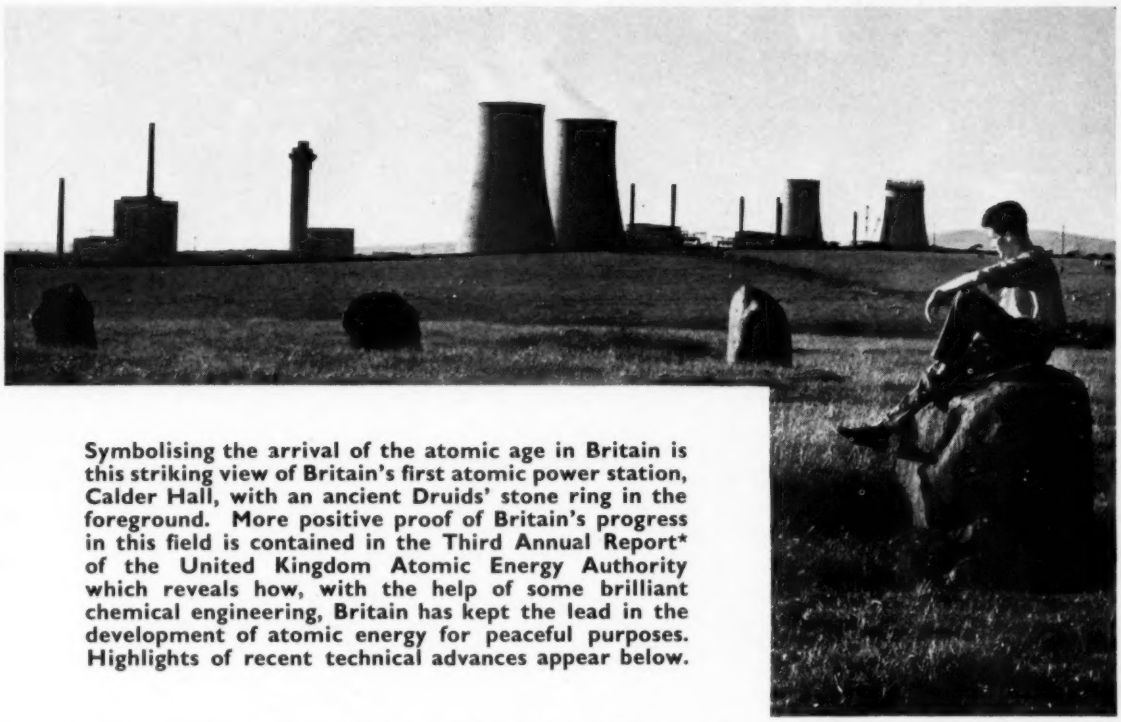
A flash cooler is usually divided into a number of pressure stages to achieve the best possible heat economy. In addition, constructional provisions are made to ensure adequate fluid distribution in the flash cooler and also to avoid loss of product by splashing during expansion.

These and other matters surrounding flash cooling are discussed in a technical bulletin of the Verenigde Machinefabrieken N.V., Holland, and among applications mentioned are flash cooling for sugared condensed milk in a dairy factory, the vacuum crystallising of salts and the preparation of cooling water for oil refineries and chemical plants. It is pointed out that large quantities of cooling water, with temperatures which usually lie between 39 and 53°F., are often required for condensing oil fractions and for crystallisers with cooling surface. If cold cooling water is only required in summer, flash coolers give the advantage that they are operated with cheap back-pressure steam. In winter the cooler is not in use and the back-pressure steam is used for heating purposes.

It is claimed that the capital investment for this type of cooling equipment is comparatively low, while maintenance costs are minimal.

ATOMIC ENERGY ADVANCES

Latest Technical Developments Summarised



Symbolising the arrival of the atomic age in Britain is this striking view of Britain's first atomic power station, Calder Hall, with an ancient Druids' stone ring in the foreground. More positive proof of Britain's progress in this field is contained in the Third Annual Report* of the United Kingdom Atomic Energy Authority which reveals how, with the help of some brilliant chemical engineering, Britain has kept the lead in the development of atomic energy for peaceful purposes. Highlights of recent technical advances appear below.

A USEFUL reduction in costs has been achieved at the Atomic Energy Authority's Springfields factory—which produces uranium metal to meet the needs of Calder Hall as well as those of the Windscale piles—by the introduction of continuous solvent extraction. The solvent extraction plant, which replaces the batch ether process for the purification of concentrates and works residues, operated according to flow sheet from the start-up with considerably fewer commissioning problems than are usually encountered on this type of plant.

The use of magnesium in place of calcium as a reducing agent for uranium fluoride was introduced early in the year.

Extension of the facilities at Capenhurst to provide additional quantities of uranium enriched in the 235 isotope has continued; meanwhile the existing plant has operated well, as has also the plant for converting the enriched uranium hexafluoride to metal which, because of the criticality risks involved, was built at Windscale, since this factory had experience of these problems.

New decanning facilities have been installed for processing the Calder Hall fuel elements after irradiation. Means for dividing the rods into lengths which can be handled by the charging mechanism of the chemical separation plant have also been provided.

It is also notable that the first large sources of caesium-137 have been extracted from the fission product solution which is separated from the uranium and plutonium in the first stage of the primary separation plant. Besides providing highly radioactive sources which have important medical uses, the removal of this long-lived isotope is a first step towards reducing the storage facilities required for this extremely radioactive fission product solution.

* H.M.S.O., 3s.

Fuels and fuel elements

A technique for manufacturing uranium dioxide, cheaper than the conventional one, has been developed in work connected with reactor fuels. The new method produces high-density specimens to accurate dimensions in a single operation. The trend in development of fuel elements for advanced reactors has been towards ceramic, rather than metallic, elements because it now appears that ceramics may be more suitable for high-temperature operation.

- ★ **Solvent extraction reduces costs in uranium production.**
- ★ **Separation of isotope from fission product solution achieved.**
- ★ **Cheaper uranium dioxide manufacturing process developed.**
- ★ **Advances in production of moderator materials.**
- ★ **Chemical treatment of fuels progresses.**
- ★ **New pressure-vessel fabricating techniques advance power projects.**

Moderator materials

Research on special grades of graphite for future reactors is being done at Harwell. An experimental plant has been commissioned and used to make specimens of about the same size as the graphite blocks used in industrial reactors. Methods of increasing the density and decreasing the permeability of graphite are being studied.

Research into methods of manufacturing heavy water has been concentrated on the hydrogen-distillation and the dual-temperature chemical-exchange processes. In the first of these, hydrogen gas is cooled to its liquefaction temperature of −253°C. and then distilled in a column, when the heavy hydrogen (deuterium) is separated from the light. An engineering design study of the process has been undertaken in collaboration with a firm of consultants and experimental work done on the development of reversing heat exchangers. A closed-cycle form of the process is also being developed in which the stripped (light) hydrogen from the distillation unit is brought into contact with natural water, from which it picks up more deuterium by chemical exchange; this enriched hydrogen is then fed through the separation process.

A theoretical design study of the dual-temperature chemical-exchange process between sulphuretted hydrogen gas and water is nearing completion, and a new method of heat recovery has been developed which makes the process more attractive for operation in Britain. A new form of the exchange process between liquid ammonia and hydrogen is also being studied.

Zirconium is of interest for canning fuel elements, but it suffers from the disadvantage that its creep strength is low. Several alloy additions capable of increasing creep resistance have been found which are acceptable on nuclear and other grounds. Techniques for fabricating and welding these alloys are being developed.

Chemical processing of fuel elements

Fuel elements removed from a reactor have to be treated chemically to separate neutron-absorbing fission products and secondary fissile material from unburnt fuel. This chemical processing forms an important element in the cost of nuclear power.

Solvent extraction processes are used at present for treating fuel elements from the Windscale and Calder Hall reactors and similar processes will be used for the fuel elements from the first Central Electricity Authority reactors. Plant requirements for these have been studied and flow sheets proposed; although the plant has been conceived as primarily for uranium fuels, the possibility that later reactors might be ' spiked ' with plutonium has been borne in mind.

In aqueous processes such as the foregoing, the fuel is treated in solution and must be converted to metal before it can be used. Processing costs might be reduced if the fuel could be kept in metallic form throughout. This might be done by high-temperature methods, *e.g.* by melting the spent fuel and removing fission products as slags. A project, known as ' Hotspur,' for studying these methods has been set up at Harwell. A special laboratory suite has been designed and built in which uranium and plutonium at activities up to 1,000 curies can be melted and treated entirely by remote control. The work has included the study of related techniques and materials. Assessments of the economics of the process have been made.

The ' Hotspur ' programme is supported by a study of methods for fabricating extracted fissile material, which will be radioactive, into fuel elements.

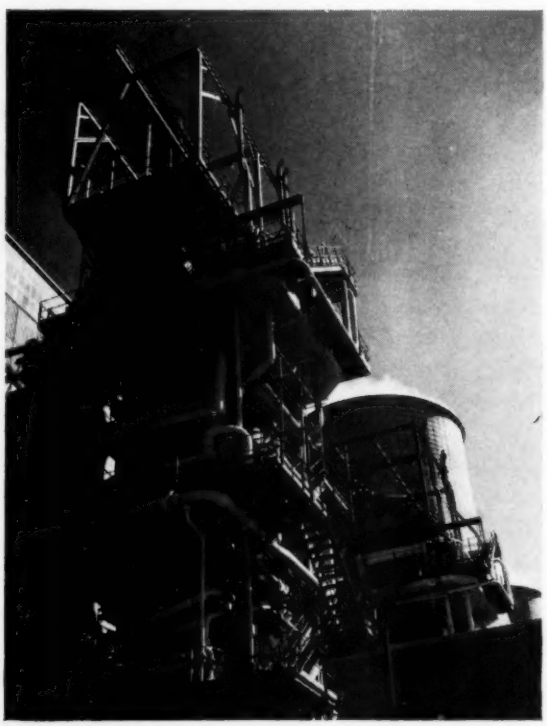
Welding progress

A major technical innovation which has made it possible to plan bigger atomic power stations than was at first envisaged is the development of techniques for welding thick steel plate. At Calder Hall, the pressure vessel containing the reactor is made of 2-in. steel plate; the first nuclear stations to be built for the electricity authorities will have pressure shells of 3-in. steel plate. This will permit an increase both in the size of the reactor and in operating pressures and temperatures. Numerous other improvements to the designs have been made. It will, for instance, be possible to charge and discharge fuel elements under load without having to shut down, as is necessary at Calder Hall.

Reactor operation

The report recalls the bringing into operation of the first reactor at Calder and the dramatic ceremony, performed by the Queen, in which electricity was released into the Central Electricity Authority's distribution grid. Generally it can be said that operating experience at Calder Hall has been satisfactory. The plant has gone into operation with less trouble than might reasonably have been expected, and it has worked reliably at the design conditions of power level and temperature; these have indeed been exceeded with satisfactory results for appreciable periods.

The additional reactors, two at Calder ' B ' and four at Chapelcross, for combined plutonium and electricity production, are due to go into operation in 1958 and 1959.



One of the four heat exchangers of No. 1 reactor, Calder Hall 'A' generating unit. In the background are the twin cooling towers.

RADIATION TECHNIQUES IN THE COAL INDUSTRY

By R. J. S. Jennings, M.A.(Oxon), A.R.I.C.
(Scientific Department, National Coal Board)

This article shows the many ways in which atomic radiation, produced as a by-product of atomic power generation, could be used by the coal industry to overcome certain problems connected with production, research and analysis.

BESIDES contributing towards the country's energy supplies there are other ways in which atomic energy could help the coal industry. One is by supplying by-product heat from the atomic reactor for coal processing purposes, while another is by offering by-product radiation or a wide range of individual radioisotopes to industry in general.

Radioisotopes are in fact saving industry in many countries millions of pounds and thousands of working hours a year.[1] Some of these isotopes are produced artificially by irradiation of selected elements in the atomic pile, while many others occur as by-products to nuclear heat generation for atomic power production. Industrially they are used for detecting, measuring, tracing and inspecting.

This article attempts to show how, with certain reservations, radioisotopes might be used to advantage in the coal industry today. No radiation technique should be embarked upon, however, purely for the sake of novelty, without an eye to improving efficiency and economy in relation to the more conventional methods available. Furthermore, radiation should be used underground only after careful consideration of the potential dangers involved.

Coal production

Radioactive mining explosives. When a mining explosive fails to detonate it can usually be detected quite easily and removed before drilling operations begin. Serious accidents can sometimes happen, however, if an undetected explosive charge is drilled. Radioactive tracers offer a means for detecting such a charge. For example, in connection with quarrying research in Canada, radioactive dynamite has been used.[2] Sb^{124} in the form of sulphide was found to be a suitable isotope for incorporation in the dynamite and this was mixed with pure chalk as a neutral filler and the whole stirred into a standard explosive composition. A directional geiger counter was used to detect radiation and during the whole experimental work the radiation level was measured at every stage. It was concluded that the tagged explosive could be manufactured and handled quite safely, it being quite possible to keep the radiation well within the tolerance dose, *i.e.* the maximum gamma radiation dose to which a person may safely be exposed continuously during working hours.

A similar technique would appear to have distinct possibilities if applied to permissible coal-mining explosives. The use of radioactive explosives would not supersede existing methods of inspection before drilling; however they may have special uses where other forms of inspection may be uncertain and the extra cost felt to be worth while.

Study of drill tip wear. To be able to use radioactive drill tips to measure the rate of tip wear is important in studies where the design of harder drilling tools is concerned. By rendering the tip of a drill radioactive by neutron irradiation in the pile, its rate of wear can be measured directly by the radioactivity of the chips. This method has, in fact, been used by the National Coal Board for the laboratory study of the wear of tungsten carbide/cobalt drill tips in research on rock drilling and determination of the optimum compositions of these drill tips.

The drill tips are made radioactive by irradiation at Harwell before being brazed to the drill bit and arrangements are provided for collecting all the rock cuttings with which is mixed the active material worn from the tips. This is relatively easy to handle, as the work can be done in the laboratory, since only short holes are necessary. A figure for wear can be obtained to an accuracy of $\pm 5\%$ from 1-ft. drilling.

An alternative method of investigating drill tip wear employed in Sweden, for example, consists in actually incorporating Co^{60}, Ta^{182} or W^{185} into the carbide cutting edge before carrying out the test drilling.[3]

Coal preparation

Sorting of coal and shale. The separation of lump coal from undesirable material is, of course, a vital operation in preparing most of our coal for industrial and domestic use. While modern coal-preparation technique has reached a high degree of development, the separation of coal from shale would be a less costly operation if it were possible to avoid using the orthodox 'float-and-sink' method in liquid media, whereby coal particles float and shale sinks. It is with these thoughts in mind that experiments on the back-scattering of gamma rays have been carried out at Harwell and in the U.S. as a means for sorting coal from shale.

The British work involved using Tm^{170} as the gamma source. Shale, which has a mean atomic number Z of about 13, scatters back less gamma rays than pure coal, whose atomic number is very nearly 6. In a test with 50 samples of arbitrary shapes and varying qualities, the counting rate of back-scattered radiations was compared with the ash content of the separate samples. Samples with ash content greater than 30% could be sorted reliably from those with ash content below 20% purely on a basis of the observed counting rates. As a result, an instrument is being developed for automatically sorting coals into different qualities at the pithead and this arrangement is expected to be more economic in use than orthodox density methods.[4, 5] The application of the back-scattering method to the sorting of coal and shale has also been investigated by the National Coal

Board at their Stoke Orchard research establishment, where experiments have indicated that a different range of wavelengths, possibly x-rays, would be more suitable.

In contrast to the back-scattering method, the Russians are tackling the problem of coal grading by measuring the degree of weakening of gamma radiation as it passes through the coal; this weakening depends upon the mineral content of the coal. The Mineral Fuels Institute of the U.S.S.R. Academy of Sciences obtained the best results using Tl^{204} as the gamma source, and a plant is being designed to carry out large-scale sorting experiments.[6]

Coal storage

Controlling the level of coal in bunkers etc. In the metallurgical industry, if the stock level in a cupola becomes too high or too low, the operation of the cupola is impaired. Conventional gauges are of the pneumatic type, in which probes are inserted into the stock at a predetermined level. If they meet an obstruction such as a stock, they immediately retract, indicating a full stock. In operation they are easily bent, become jammed, or misgauged by entering a void in the stock. A gauge has been designed in America which uses the absorption of gamma rays as an indication of the presence or absence of stock at a selected level. The gauge proved reliable and successful and was coupled to the charging mechanism to permit automatic charging.[7]

The gamma-ray indicator was also used in a series of industrial tests carried out in 1955 at a Russian coalfield, the object being to control automatically the level of coal in bunkers and skips. The source of gamma radiation was radio cobalt. Owing to the success of the tests, the introduction of gamma indicators on a large scale is under consideration.[8]

Coal Treatment

Investigation of the carbonisation process. Of all coal-processing methods, none has received more universal attention than carbonisation. Now that good coking coals are becoming scarce and coals formerly thought to be unsuitable for coking have to be used for this purpose to an increasing extent, it is essential that the carbonisation process should be made as efficient as possible. While much has been accomplished in this direction, the use of a radioisotope technique might bring about a further improvement in efficiency by enabling the movement of solids and gases in the carbonisation chamber to be followed. This technique has in fact already been used experimentally by our gas industry to measure the rate of descent of coal in a vertical retort. A radioactive source is introduced into the coal at the top of the retort, and its position determined at intervals by means of water-cooled geiger counters in the combustion flues[9] (see Fig. 1).

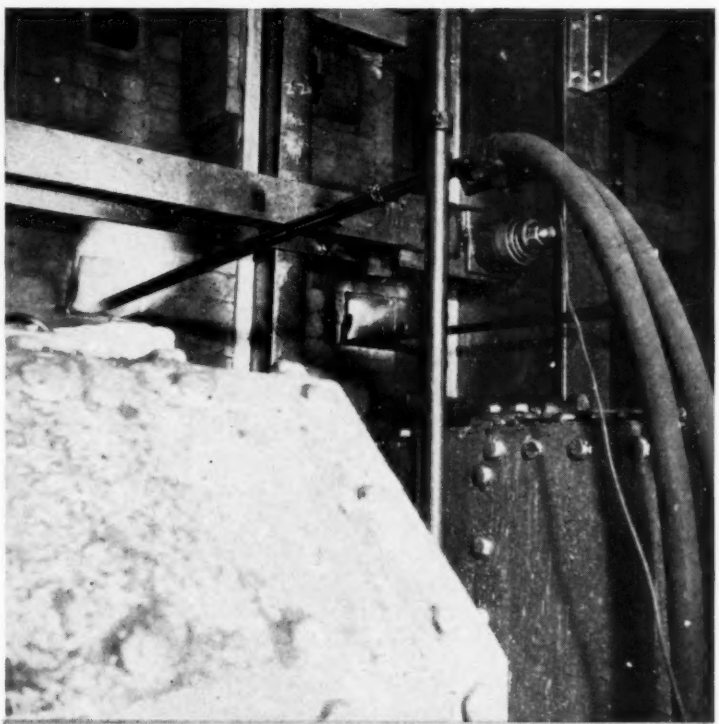
A radioisotope method has also found experimental application in the iron and steel industry in Britain and America to determine the movement of materials in the blast furnace. The movement of gases in the furnace was investigated by introducing a radioactive inert gas through the tuyeres.[10]

The gamma radiation from Co^{60} has been used by the Esso Standard Oil Co. in the U.S. to measure the top of the dense bed of fluidised coke in their fluidised petroleum coking work.[11] Density measurements were correlated with pressures, and pressure instruments were calibrated to give subsequent data on bed levels and densities by direct reading. Similar control measures would be adapted to the fluidised carbonisation of coal, which is receiving wide attention both here and abroad.

Underground gasification. Experiments on gasifying coal *in situ* have been carried out in various countries for some years with a view to making use of coal seams which cannot be mined economically. The purpose of the gasification work in general is to produce low-grade gas to fire boilers for electricity generation, but in some cases gas of high calorific value which can be used for synthesis purposes is obtained.

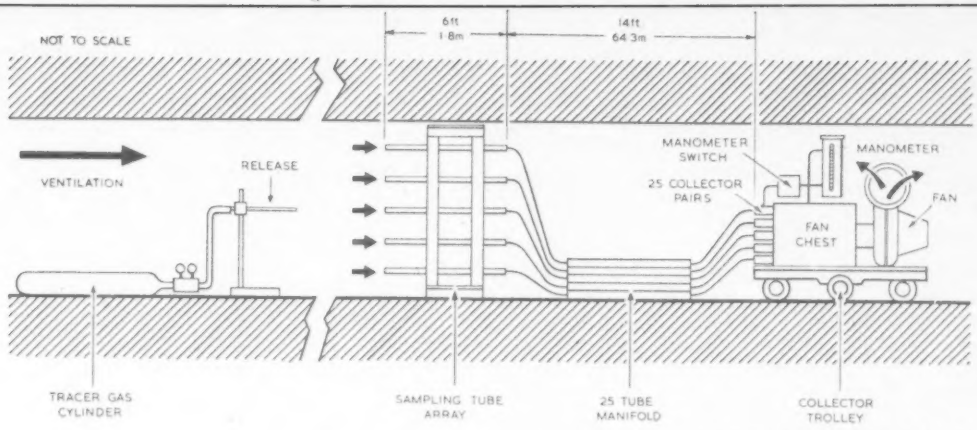
In Britain, trials associated with the Ministry of Power, the National Coal Board and the Central Electricity Authority[12] have led to a small electricity generating plant being planned for the near future.[13]

In certain experimental underground gasification work in Britain it became necessary to effect a junction between vertical boreholes and an inclined underground borehole drilled from a surface outcrop. In order to carry this out the points of closest approach of these vertical holes with the inclined hole had to be determined, so that the minimum quantity of explosive could be used in the right place to join them together.[14, 15] This was achieved



[*Courtesy: Institution of Gas Engineers*

A water-cooled probe is used to detect the position of a radioactive tally in a vertical gas retort.



[*Courtesy: Crown Copyright, S.M.R.E.*

Arrangement of tracer-gas release and sampling apparatus in a coal-mine gallery.

successfully with the aid of a Co gamma-ray source in the inclined hole and a counter attached to recording equipment in one of the vertical holes.

Liquid flow and pipe corrosion. As in the petroleum industry, radioactive tracers could be employed by the coal industry to measure both flow and density of liquids passing through pipes and also to mark interfaces between different fuels transported consecutively through the same pipeline.[16]

Water flow can be tagged with H^3 or tritium, and intensive work with water tracers was started in the U.S. Bureau of Mines laboratories in 1951.[17] Within the coal industry radioactive tracers could be used to trace the path of underground mine waters, and might well assist in certain effluent problems associated with coal processing.

Radioisotopes are also useful in measurements of pipe corrosion. With a simple thickness-gauge 'corrosion meter' it is possible to measure from the outside any deviation in pipe thickness to $\pm 4\%$.[18] Such a device might conceivably find a use in the coal industry for inspecting pipes responsible for conveying corrosive liquids from carbonisation plants or as a means for checking pipes used in the drainage or treatment of acid mine waters.

Health and safety

Ventilation studies. A knowledge of airflow underground is essential to the health of underground workers, and precise measurement is extremely difficult with conventional instruments.

A gauge depending upon the use of radioisotopes has been developed in America, and this instrument measures the mass of air flowing past a stack of plates per unit time. The air is ionised by alpha particles from thin foils of radium attached to the plates, and the gauge then measures the subsequent ionisation current, which is proportional to the airflow.[7] This device has been applied successfully to air-conditioning problems and this type of instrument might conceivably be used to investigate underground air flow problems.

Flow of methane in strata. Complementary to ensuring an adequate supply of air to the miner, it is, of course, vitally important that potentially explosive mixtures of gases, or of gases and coal dust are not allowed to accumulate underground. Radioisotopes might once again be called upon in this connection. For example, the passage of methane (firedamp) in underground ventilated areas can be traced by introducing one of the radioisotopes of the inert gases (*e.g.* $argon^{41}$ or $xenon^{133}$) into the system and employing detecting devices.[3] Furthermore, the Safety in Mines Research Establishment of the Ministry of Power has recently carried out studies on the application of a radioactive tracer method to the examination of the turbulent diffusion of gas and fine dust in mine ventilation currents.[19] The tracer used in this work was $bromine^{82}$ in the compound methyl bromide.

The release, sampling and measurement of the tracer are carried out as follows:

Methyl bromide vapour diluted with air is contained in a cylinder under a pressure of about 50 atm. The diluted bromide is then released at the desired rate from the cylinder in large-scale experimental galleries (Fig. 2). Further downstream, at the cross-section under investigation, the air is sampled by a collection of 25 sampling tubes and the methyl bromide is absorbed on granulated charcoal. After each experiment the charcoal collectors are removed from the trolley and their gamma radiation is measured by a scintillation counter. The relative count rates, corrected for the rates of aspiration, give the relative concentrations of tracer gas at the sampling points.

A radioisotope of methane itself has been proposed by the Russians for measuring the gasiness of a coal seam.[20, 21] A knowledge of the amount and direction of flow of methane in coal strata is important for, in highly gassy coal seams, it is customary to drain off large quantities of methane, not only to make the seams safe for men to work, but also to make use of the high B.Th.U. gas obtained in order to generate power, or possibly to make chemicals.

Radio-isotopes in fuel chemistry research

By the use of isotopically labelled compounds it is possible to determine the mechanism of certain chemical reactions and to estimate desired components of reaction mixtures. A few examples will serve as illustrations.

Fischer-Tropsch process. Although economic conditions in Britain at the present time are not in favour of making oil from coal, nevertheless it is important that we know how to do it should the need ever arise. To this end experiments on the Fischer-Tropsch process (which could be an essential step in an oil-from-coal

project) have been conducted at the D.S.I.R. fuel research station for a number of years.

One aspect of this work entails the irradiation of Fischer-Tropsch catalysts[22] with a view to improving their efficiency. The mechanism of the Fischer-Tropsch process using radio carbon in a cobalt-catalysed reaction has also been examined at the fuel research station, while the mechanism of the process on an iron catalyst has been studied in the U.S.[16, 23, 24]

Thermal oxidation of methane. The mechanism of the thermal oxidation of methane has been investigated by means of tracer technique,[25] and the results of such work should be valuable not only to bodies interested in making gas, fuels or chemicals, but also to all who are concerned with the safety of underground mining operations, for whom a knowledge of the mechanism of firedamp explosion is of great importance.

Other reactions being studied by means of tracer technique include the $C\text{-}CO_2$ reaction, important in interpreting combustion and gasification processes,[23, 24, 26, 27] and the behaviour of sulphur compounds during carbonisation.[24, 28]

Separation of hydrogen-containing gases. Of the radioactive isotopes that can be produced in quantity in nuclear reactors, tritium is one of the most interesting because of the variety of potential research applications for which it is suitable.[29] The use of tritium-labelled materials should facilitate studies involving the separation of hydrogen-containing gases and therefore could find some useful application in any process calling for the separation from process streams of hydrogen for hydrogenation work.

Radioisotopes in analysis

Probably no single technique developed in recent years has proved more versatile in solving all manner of different analytical problems than that involving the use of radioactive tracers. The following examples will serve to illustrate how this technique can be applied to analytical requirements met with in the coal industry.

Determination of sampling error. The French coal research establishment (Cerchar) have employed an irradiation technique in connection with their semi-micro method for the determination of carbon and hydrogen in coal. This semi-micro method is very rapid, but it presupposes a high degree of homogeneity of the sample. By chemical analysis, errors due to sampling cannot be distinguished from those due to analysis itself. On the other hand, if the coal is irradiated in an atomic pile, so that only the mineral matter of the coal becomes activated, then the activity measured by a counter is a function of the mineral matter content. Activation measurements can be repeated as often as required on the same sample, which enables dispersion due to sampling to be assessed.[30]

Determination of known organic components of coal tar. If it is required to find the amount of a certain organic substance present in a mixture such as coal tar from which it is difficult to separate completely, the addition to the tar of a small quantity of this particular component containing a suitably labelled atom will enable a quantitative determination to be carried out, provided that some of the component can be removed in a pure state.[24] This is known as the Isotope Dilution Method. The chemical research laboratory of the D.S.I.R. at Teddington, Middlesex, developed the method for determining naphthalene in high-temperature coal tar using C^{14} labelled naphthalene.[31] A measured quantity of the labelled substance of known radioactivity is added to the tar or tar fraction, and a small amount of the pure hydrocarbon is isolated. By comparing the radioactivity of the isolated sample with that of the material originally added, the amount of substance in the tar or oil can easily be calculated. This method is being perfected by the Coal Tar Research Association at Gomersal, near Leeds, for the determination of phenanthrene and fluorene and the general technique would appear to have wide applications.

Determination of the sulphur content of coal. Good metallurgical coke must contain very little sulphur, and so there has arisen the necessity for determining the sulphur content of coals used for such coke making.

In America the sulphur content of coal has been determined by a radioisotope technique. To find whether pyritic or organic sulphur in coal was the more important in determining the total sulphur content of coke, pyritic sulphur was synthesised with S^{35} and mixed with 10 tons of powdered coal containing ordinary pyritic and organic sulphur. For the first 6 hours' carbonisation, pyritic sulphur evolved more slowly than organic, but the converse applied for the next 7 hr. The net result was an almost equal rate of evolution. This work shows then that, under normal coke-oven conditions, there is no advantage in using coal with a high ratio of pyritic to organic sulphur in order to produce low-sulphur coke.[32]

Another method which has been applied to liquid or solid petroleum products involves a device designed to record a quantitative analysis of sulphur in these products. The principle is based on the resonant absorption by sulphur of manganese x-rays whose source is Fe^{55}. In petroleum products minute amounts of sulphur can be analysed to $\pm 0.05\%$ in a space of 5 min. by non-technical operators.[16, 33]

Determination of impurities in inorganic by-products. Radio activation is proving to be a powerful analytical tool for the determination of small amounts of important metallic impurities in substances. In particular, the technique has been applied to determine the arsenic content of germanium, a metal whose evaluation interests the National Coal Board, for it is a by-product obtainable from producer-gas flue dust. Now the very important new development of transistors (diode or triode valves made from germanium) depends essentially on the production of very pure germanium metal of very low arsenic content, for example. The most sensitive conventional method of analysis—the spectroscopic method—can determine impurities down to a few parts per million; if, however, the material is irradiated in the pile, it is possible to measure the arsenic content by the radio arsenic produced and to determine levels down to 1 part in 100 million,[15, 34] a level of concentration satisfactory for transistor germanium.

Miscellaneous applications

The preceding survey of the uses and possible uses for radioisotopes in the coal industry is far from exhaustive. Many other uses spring to mind, several of which result from the development of the gamma-ray-indicator type of apparatus already mentioned. Gamma gauges might find application in all kinds of current and potential methods of coal treatment and the newer gasification processes, in particular.

It has been proposed in Russia[20] that a Co^{60} gamma source used in conjunction with a counter could be employed to measure the density of coal in various sizes, shapes and degrees of compaction, but the method has been subjected to criticism.[21] This same sort of device has been proposed for measuring the amount of coal being conveyed on a belt.[20]

In the U.S. an atomic detecting device has been used recently in connection with the hydraulic transport

of coal slurry in a long pipeline.[35] The detector reflects changes in the consistency of the slurry and automatically regulates the appropriate mixture of coal and water. A gamma-ray co-ordinator could be used to determine whether conveyor belts and chains were in working order for co-ordinating the movement of conveyor relative to the tubs[36] and for steering purposes in directed drilling.

Successful tests with gamma-ray indicators were also made in connection with automatically counting mine cars and stopping electric locomotives.[8, 36] Thus when a mine car passed through a beam of gamma rays the beam became cut off, and the action activated a counting mechanism. In the case of a locomotive, the beam cut-off action caused a red light to be switched on. It is important to note, however, that such operations as the measurement of the quantity of coal travelling on a conveyor belt, counting mine cars and automatically stopping electric locomotives can be carried out equally satisfactorily by classical methods.

It is possible that radioisotopes could be used in the study of rock pressure in relation to roof control, and in sudden outbursts of coal and gas.[36]

Neutron scattering has found a number of applications where control of moisture is important. It has, for example, been used to measure soil moisture, is under consideration as a means for measuring moisture in grain, timber and stone[4, 33] and may be adaptable to the determination of moisture in coal,[20] although this would seem to be no easy task.

Further possible uses

By-product radiation from the atomic reactor might also be used in the field of fuel chemistry to initiate reaction in mixtures in which no reaction normally takes place, or to enable processes which normally take place under severe conditions of temperature and pressure to be operated under much milder and therefore more economic conditions. In this connection, the application of radiation to by-products from coal carbonisation might be interesting. As a matter of fact it has recently been announced in the press[37] that, in laboratory experiments carried out by the Standard Oil Co., petroleum has been produced by the action of radiation on heavier oil and on refinery gases.

Finally, there is considerable demand, particularly in the aircraft industry, for plastics and rubbers which will withstand high frictional temperatures[38] and a parallel demand exists in the coal industry for conveyor belting which will withstand high temperatures without taking fire. Much valuable work on producing fireproof conveyor belts has already been accomplished, but radiation might help in two ways, firstly by modifying the properties of the finish polymers and, secondly, when used in the manufacturing process, by actually producing a polymer with superior high-temperature properties, for example, in the vulcanisation process.

Conclusions

In certain special cases the use of radioisotopes by the coal industry should hold forth the promise of improved and cheaper processes, improved materials and a more careful control of existing processes. However, before deciding to apply a radiation technique, the more conventional methods of control or analysis should be explored fully not only for economic reasons, but particularly when it is a question of using radioactive material underground.

Acknowledgment

Thanks are due to the Director-General of Research, Scientific Department, National Coal Board, for permission to publish this survey.

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Gas separation symposium

The Low Temperature Group (the Physical Society) and the Institution of Chemical Engineers are jointly organising a one-day conference on 'Recent Developments in Industrial Low-Temperature Gas Separation.' The conference will be held on November 26, 1957, at the Royal Institution.

Because they provide the drive which circulates oil through the plant, pumps form the heart of an oil refinery. The reliability required is met by special care in their design and selection.

Pumping Petroleum Products

THE modern oil refinery presents considerable problems in fluid handling, both as regards volume and complexity of services. With a throughput of many thousands of barrels a day, a large number of individual processing units are scattered over an area often extending over hundreds of acres. The pumps driving the fluid on its long journey through the refining processes are in effect the sole motive power of the entire plant. As such, they have to deal with a wide variety of liquids ranging from liquefied gases to heavy fuel oil and bitumen. In addition to the basic petroleum products, pumps also have to deal with large quantities of cooling water and other liquids used indirectly in the process.

Sheer volume of throughput, however, raises few problems. Most difficulties arise partly from the extremely severe process conditions imposed by refinery operation. At some points the oil is cold, while at others it is so hot that special precautions must be taken to avoid leakage as it would ignite spontaneously on contact with the air. Some processes call for very high pressures, others for high rates of flow. Above all, every pump must have built into it a very high degree of reliability, since the operation of a modern refinery is so closely integrated that the failure of a single section can sometimes have a major effect on the economic operation of the whole plant.

An excellent example both of the complexity of the task and of the reliability of pumps at a modern refinery is to be seen at the Shell Haven refinery of the Shell Refining Co. Ltd., which includes facilities for the production of motor spirit, fuel oil and a wide range of other petroleum products from crude oil. An important section of the process pumps at Shell Haven, about a hundred in number, was supplied by Sigmund Pumps Ltd., of Gateshead-on-Tyne, in a range of types, each designed to meet a specific requirement.

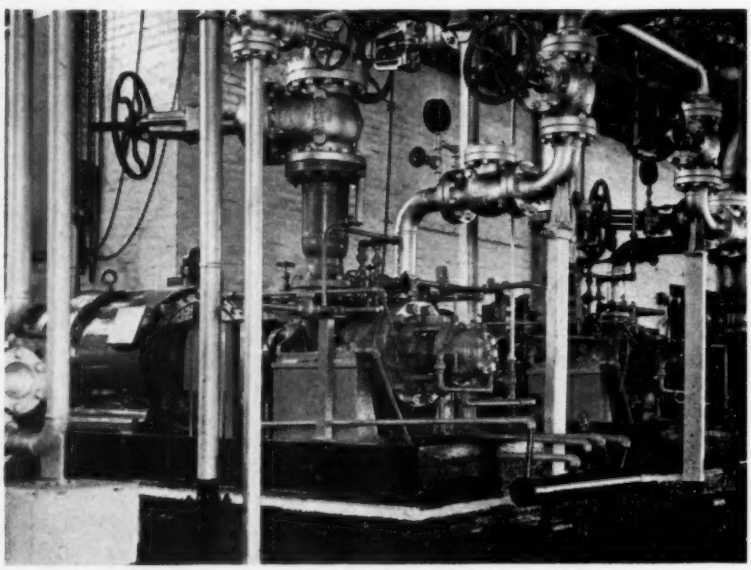


Fig. 1. Close-up of one of the HO-HL6Y process pumps at Shell Haven. Note the convenient top entry of suction and discharge branches, and the sensible grouping of cooling water pipes.

Thermal reforming unit

Some of the most interesting applications of these process pumps occur in the thermal reforming unit, where straight-run naphtha from the main distillation unit is upgraded to produce a series of gasoline components for ultime blending into motor spirit. In the course of this process, a wide variety of liquids have to be circulated through the fractionation column, crackers, condensers, heat exchangers, debutanisers and reflux circuits which make up the plant.

The thermal reforming unit makes exceptionally heavy demands on its pumps, partly because of the pressures and temperatures involved, and partly because of the high rates of flow required. Among the most important pumps are those which deliver the condensate to the debutaniser at high pressure.

Two such process pumps are installed, one of which is used continuously while the other acts as a standby. Alternate operation is not employed and hence it is necessary that the pumps work for very long periods without maintenance.

Details of pumps

The pumps, which are illustrated in Fig. 2, are two-stage process pumps type HO-HL6Y. They work on a suction pressure of 200 p.s.i. and discharge at 415, giving a differential pressure equivalent to a head of 785 ft. To withstand this working pressure, the pump casing is made of cast steel of 1 in. minimum thickness, which incorporates $\frac{1}{8}$ in. allowance for corrosion; a hydrostatic pressure test on the casings before assembly at 600 p.s.i. ensures an adequate safety margin. To minimise the danger of misalignment and stresses at high temperatures, centre-line mounting has been adopted.

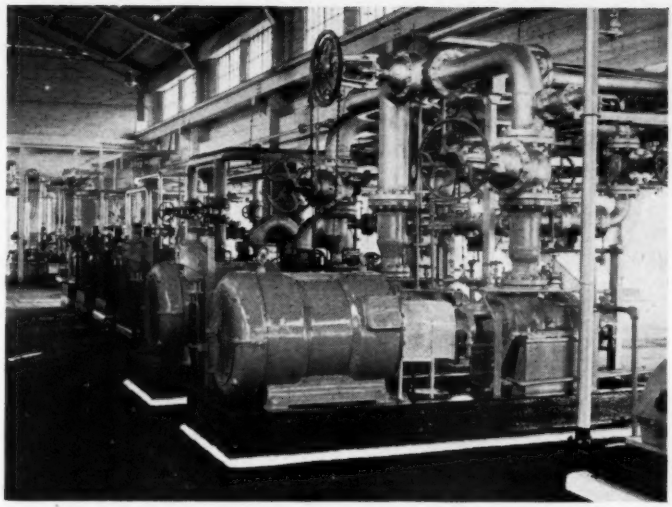


Fig. 2. Some of the Sigmund process pumps in the thermal reforming unit. The two nearest the camera are used to charge the debutaniser at a pressure of 415 p.s.i.

Back-to-back impellers

The two impellers are placed back-to-back to balance axial thrusts and are mounted on a heat-treated steel shaft fitted with hard *Stellited* sleeves in the stuffing box sections. The impellers have stainless-steel wearing rings bearing on rings of similar material in the case. The shaft, which is driven by a 100-h.p. electric motor, runs in a substantial roller bearing at the driven end; a double-row ball bearing at the opposite end takes care of any residual thrust loads, both bearings being generously water-cooled.

Sealing arrangements are thorough, with soft-type packing in the stuffing boxes, which are also water-cooled to ensure long life. Further cooling is provided by the sealing liquid which circulates through the lantern ring spaces. Great attention has been given to reducing hydraulic losses in the pump. The impeller eyes are carefully designed to reduce shock losses to the minimum, and a well-profiled change-over passage ensures smooth flow between the stages. Mechanical smoothness is assured by accurate dynamic balancing of the shaft assembly.

Easy maintenance features

A special feature of the design is the importance attached to accessibility and ease of maintenance. It will be seen from Fig. 1 that both suction and discharge branches are integral with the casing and are placed at the top of the pump, allowing easy access to all parts of the unit. The vertically split casing permits complete dismantling without breaking pipe connections or disturbing the driving motor. This avoids the danger of disturbing the alignment during maintenance. All cooling water pipes are sensibly located, and of the same standard layout as for other pumps in the range, which greatly simplifies the work of the maintenance engineer.

It was considered necessary to provide only one debutaniser reflux pump (type HO-HK5). However, pipework and valves are so arranged that one of the debutaniser feed pumps can be used in reflux service if required. The operating characteristics of the type HO-HL6Y are well within the required range.

A feature of this plant is the use of the distillation residue as a heating medium in one of the plant heat exchangers. The high rate of flow required and the high temperature of the liquid present special problems for the two Sigmund type HO-QA6 process pumps used for this purpose. From the safety angle, leakage must be prevented, so that perfect sealing is essential.

The arduous duties carried out by the process pumps described here may be regarded as typical of those met with all over the site.

To Authors of Technical Articles and Books

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Stratford House, 9 Eden Street, London, N.W.1.

In addition, the Publishers and Editors of the Leonard Hill Technical Group are always ready to consider technical and scientific manuscripts with a view to publication. Correspondence should be addressed in the first instance to the Book Production Manager, at the above address.

Italian electrolysers for Indian fertiliser and heavy-water project

Among the vast schemes of development that are being undertaken by the Indian Government as part of its second five-year plan is the Nangal fertiliser and heavy-water project. The site of the project is on the Sutlej River in the northern Punjab. The whole project, together with the allied hydroelectric scheme, is closely linked with plans for improving irrigation and agricultural productivity.

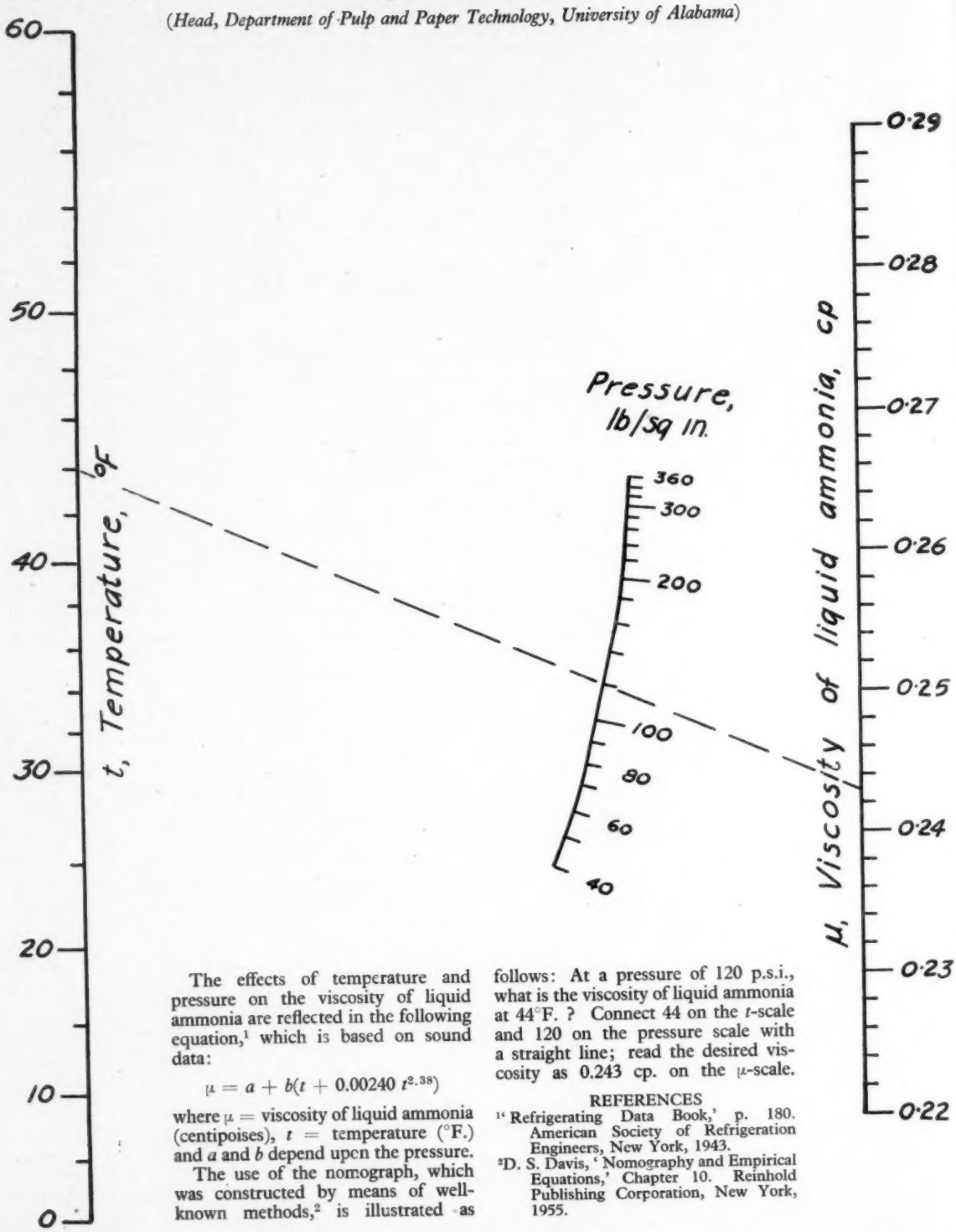
The total cost of the project, including the electrolysis, fertiliser and heavy-water sections, will approach $60 million, of which some $45 million will be spent on plant and equipment. The project is scheduled to be completed by the end of 1959 and full production should be reached early in 1960. It is expected that 80,000 tons of nitrogen will be produced annually in the form of ammonium nitrate and nitro limestone. The production of heavy water is expected to reach about 15 tons p.a.

An order for electrolysers has gone to Oronzio de Nora, Italy, which reports that some 6,500 cells grouped in 60 electrolysers of the filter-press type, each rated at 10,000 amp., will be installed. These will enable more than 25,000 cu.m./hr. of hydrogen to be produced. This plant will be bigger than any other comparable unit completed or under construction anywhere in the world, including that envisaged under the Aswan development scheme. The power required by the electrolysers will be approximately 140,000 kw. This will be made available from the Bhakra Nangal power station, which is now nearing completion and is located close to the electrolysis and fertiliser plant. One of the considerations which determined the choice of the Indian Government was the relatively high figure which de Nora was able to guarantee with regard to the separation factor of the deuterium. This will enable the related production of heavy water to be increased above what was originally estimated.

Nomogram: Viscosity of Liquid Ammonia

By D. S. Davis

(Head, Department of Pulp and Paper Technology, University of Alabama)



The effects of temperature and pressure on the viscosity of liquid ammonia are reflected in the following equation,[1] which is based on sound data:

$$\mu = a + b(t + 0.00240\ t^{2.38})$$

where μ = viscosity of liquid ammonia (centipoises), t = temperature (°F.) and a and b depend upon the pressure.

The use of the nomograph, which was constructed by means of well-known methods,[2] is illustrated as follows: At a pressure of 120 p.s.i., what is the viscosity of liquid ammonia at 44°F. ? Connect 44 on the t-scale and 120 on the pressure scale with a straight line; read the desired viscosity as 0.243 cp. on the μ-scale.

REFERENCES

[1] 'Refrigerating Data Book,' p. 180. American Society of Refrigeration Engineers, New York, 1943.

[2] D. S. Davis, 'Nomography and Empirical Equations,' Chapter 10. Reinhold Publishing Corporation, New York, 1955.

Contributions of Ion Exchange to Nuclear Technology

By L. D. Roland, M.Sc.
(*Permutit Co. Ltd.*)

Well known for its use in water softening and demineralisation, ion exchange is a chemical engineering operation which has played an important part in uranium extraction and purification, nuclear reactor water treatment, zirconium purification and waste disposal, as this article shows.

ABOUT one hundred years ago Wey and Thompson found that certain soils possessed ion-exchange properties. They noted that when ammonia was absorbed by these soils there was a displacement of an equivalent amount of calcium. Nothing more was made of this observation until the beginning of this century, when Dr. Gans, using natural zeolites, softened water by ion exchange.

Since then the practical applications of this process have developed at an ever-increasing rate. The original materials were cation exchangers and their primary use was in the softening of water by the sodium/calcium exchange—a solution of sodium chloride being used as the regenerant. Improved cation materials were developed and in 1935 Adams and Holmes made synthetic resins having both cation and anion exchange properties. The way was then open for complete removal of dissolved ionic solids from water, and the world's first commercial demineralising plant for the production of distilled quality water without distillation was installed in England in 1937.

Although the largest industrial use of ion exchange is, and will always be, in the field of water treatment, the number of other applications is steadily increasing. Amongst these is its use in the atomic energy field.

Here, again, there is one prime use and a number of subsidiary ones. It is for the extraction of uranium from low-grade ores that it is chiefly known, but other applications include the treatment of radioactive wastes, the purification of zirconium and water control in nuclear reactors.

Uranium extraction

Uranium was first obtained as a by-product in the extraction of radium from its ores, from such rich deposits as the Belgian Congo, Czechoslovakia, etc. With the advent of atomic weapons—later atomic power, and other peaceful uses of radioactive materials—these sources were not sufficient and more had to be developed.

Although rich deposits were discovered in Colorado, northern Canada and elsewhere, for which normal recovery methods were economic, many others of far lower grade ore were found which would have proved uneconomic to work had it not been for a discovery in the field of ion exchange. Amongst these are the extensive deposits in the Blind River area of Ontario, Canada, where the ore body is little more than 0.1% uranium and not associated with any other valuable metal, and the Witwatersrand area of South Africa, where it is associated with gold.

Whilst working on uranium ores it was discovered at both the Battelle Memorial Institute, Ohio, and the Dow Chemical Co., in California, that when uranyl phosphate solutions were passed through a strongly basic anion resin, the uranium was absorbed (actually this discovery was somewhat accidental because workers passed the solution through the resin to separate the phosphate and uranium by anion exchange).

This observation was immediately developed by workers at the Massachusetts Institute of Technology and the Chemical Research Laboratory, Teddington, who were working on the South African ores. A team from these bodies and the Dow Chemical Co. went to South Africa in 1950 and the first resin columns were set up at Western Reefs.

Since that time the whole process has been developed by a large number of authorities until today it is the heart of any uranium mill where leaching of the ore is carried out with acid.

The process

To appreciate the ion exchange process it is necessary to have a knowledge of the entire uranium ore treatment. The fine ore is leached with sulphuric acid in the presence of an oxidising agent, such as manganese dioxide or sodium chlorate, where the uranium is taken into solution, together with a number of other constituents of the ore. These will depend on the leach conditions, but may include, if present, ferric and ferrous iron, calcium, soda, magnesium, copper, titanium, thorium, rare earths, etc.

After leaching, the pulps are either filtered or settled in a counter-current decantation plant to give a clear solution suitable for feed to the ion-exchange columns. It will probably be found necessary during this stage, or before it, to adjust the *p*H of the liquor to give an optimum value for the exchange process. This should be as high as possible, consistent with stable solutions—because this gives the best resin loadings. An increase in *p*H from 0.5 to 2.0 more than trebles the capacity of the resin for uranium. In actual practice, *p*Hs in the region of 1.8 to 2 are used.

The clarified, uranium-bearing liquor (pregnant liquor) is passed through the anion exchange columns where all the uranium, together with ferric iron, is absorbed. The stripped or barren liquor containing other metals passes on and is eventually sent to waste.

At Rum Jungle, Australia, where the ore contains copper, this is recovered from the leach liquor by cementation.

The uranium is displaced from the resin by eluting with an acid solution of a salt (sulphuric acid/sodium chloride or nitric acid/sodium nitrate being examples). The uranium-rich eluate is sent to the precipitation section for the final steps in the extraction process.

If lime is added to raise the *p*H to 3.5, then the ferric iron is precipitated. This is removed with the

help of a thickener and filters and the clear liquor passed forward to the next stage of precipitation. Here the *p*H is raised to 6.5 by the addition of ammonia or magnesia. The uranium comes down as a mustard-coloured yellow precipitate, which is then thickened and filtered. The filter cake is dried, packed into drums, and sent off to the uranium metal plant.

The filtrate from the last precipitation section will contain the neutral salt used in the elution circuit, consequently the strength of this salt is adjusted and acid added so that it can be returned to the ion-exchange plant for re-use.

In mills where the iron content of the ore is low, the first stage of precipitation can be omitted. Although this leads to a degraded concentrate, the final product may still be acceptable.

Chemistry of uranium ion exchange

Absorption. If a pure solution of uranyl sulphate in the presence of sulphuric acid is passed through a strong base ion-exchange resin in the chloride form, then the uranium is absorbed. It is found that for every UO_2 group which is taken up, 3 SO_4 groups are absorbed and 4 Cl ions are liberated, thus the uranium complex is taken to be $UO_2(SO_4)_3^{4-}$ and the reaction

$$UO_2^{2+} + 3SO_4^{2-} + 4RCl \rightarrow R_4UO_2(SO_4)_3 + 4Cl^-$$

With the resin in the sulphate form the process seems to be one of addition, since if a solution of uranyl sulphate is passed through the resin, it is completely absorbed and water emerges at the bottom. In this case

$$UO_2^{2+} + SO_4^{2-} + 2R_2SO_4 \rightarrow R_4UO_2(SO_4)_3$$

Ferric iron also forms a sulphate complex which is taken up by the resin. As the resin has a much greater affinity for the uranium complex than for the iron one, it is able to take up uranium from dilute solutions even in the presence of large excesses of ferric iron. For example, in a case where the ferric concentration was five times that of the uranium present in solution, the ferric concentration on the resin was only one-ninth of the uranium.

In plant practice it is found that to begin with, all the uranium and ferric iron is taken up, but as the resin becomes loaded, the uranium displaces ferric iron. Consequently, after breakthrough of ferric iron, its value rises to more than that in the pregnant liquor and this state of affairs exists until the resin is completely loaded. (Fig. 1.)

Elution. The uranium is removed from the resin by eluting with an acidified solution of a salt. Molar ammonium nitrate in the presence of 0.2M nitric acid has been found to be the most efficient for this, but in plant practice, for economic and for other reasons, different combinations are often used.

During elution the ferric iron remaining on the resin is first eluted in the presence of only a small quantity of uranium. By making a suitable cut and recycling it is possible to improve the quality of the product. Alternatively, by splitting the precipitation of the eluate, the same object is achieved.

A typical elution curve is shown in Fig. 2.

Plant operation

It will be seen from Fig. 1 that as the pregnant liquor passes through the resin there comes a time when it no longer absorbs all the uranium entering. This point (*A*) is known as breakthrough. If absorption were stopped here and the column eluted, the resin would not be saturated with uranium because although after breakthrough some uranium is not absorbed, it is not until point *B* that the strength in the effluent reaches that of the head liquor. Moreover, the eluate would contain a much higher proportion of ferric iron than if the absorption was carried on to point *B* and then the column eluted.

In plants, two or even three columns are run in series, so that the lead column is absorbing some but not all of the uranium and the trailing column or columns are picking up any uranium passed on from the lead column. Where breakthrough occurs at the bottom of the trailing column or when the lead column is completely saturated, then it is eluted. A fresh column is put in series after the column which has broken through, and the latter becomes the lead column —absorption carries on as before.

From the curve Fig. 2 it will be seen that the majority of the uranium is displaced during the first half of the elution. Consequently, the first half of the eluate is passed to the precipitation circuit, but the second half is kept back and used on a subsequent elution. This leads to richer eluate solutions and, at the same time, reduces the size of the precipitation circuit.

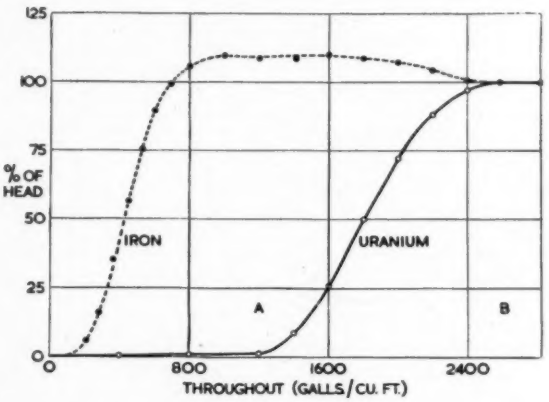


Fig. 1. After breakthrough of ferric iron, its value rises to more than that in the pregnant liquor and this state of affairs exists until the resin is completely loaded.

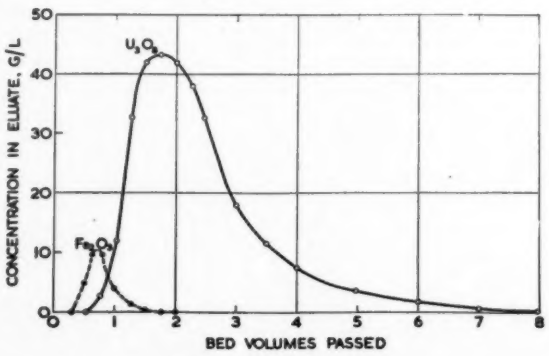


Fig. 2. Uranium is removed from the resin by eluting with an acidified solution of a salt. Here is a typical elution curve.

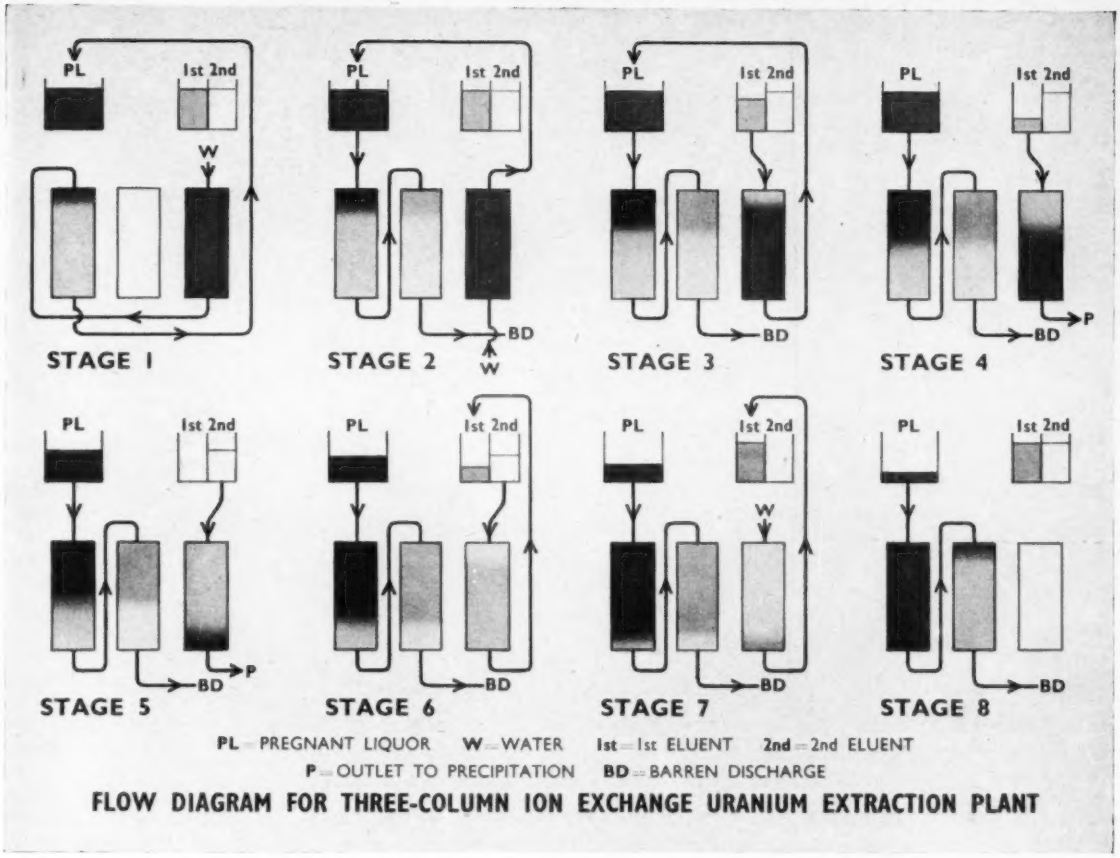


Fig. 3. A simple illustration of how, in practice, three ion exchange columns can be operated in series, as explained below.

Three-column plant

As a result of these various complications, the operational cycle for a three-column ion-exchange uranium plant is shown in Fig. 3.

Just prior to stage 1, columns *CA*, in that order, were on absorption. Column *C* having become saturated, an elution was commenced.

During stage 1 water is admitted at the top of *C* and displaces the pregnant liquor through *A* back to the leach circuit. Due to the fact that hydrolysis may occur, particularly if the raw water is at all alkaline, it may be desirable to acidify this water.

In stage 2, column *C* is backwashed with water; its object is to open up the bed so as to prevent any possibility of short-circuiting during the elution and subsequent run.

Although the ion-exchange columns should only treat clarified liquor, there is always the possibility of some slimes coming through, and this backwashing also helps to clean up the resin bed.

Whilst this is going on, columns *A* and *B* are on absorption. Column *B* will have been the one previously eluted and so the resin is completely fresh. The barren liquor leaving the bottom of *B* goes to waste.

In stage 3 first eluent, which has been used before for the second half of the previous elution, and so contains some uranium, is admitted to the top of column *C*, thus displacing the water which is taken back to the pregnant liquor storage. This stage comprises approximately one bed volume.

In these first three stages the liquor leaving the column being eluted is likely to contain some uranium and consequently must be returned to the leach circuit. It is shown in the diagram going back to the pregnant liquor tank, but in actual practice it is better if this is somewhat further back.

In stage 4 the rich eluate is sent to the precipitation circuit—this portion of the elution corresponds to the peak shown in Fig. 2. At the end of stage 4 the resin bed will be full of first eluent.

This is displaced in stage 5 with second eluent, again to the precipitation circuit; approximately one bed volume is required. The second eluent is fresh eluent and so uranium-free. From a plant that is in normal operation this has been returned from the precipitation circuit after its concentration of salt and acid has been adjusted.

During stage 6, second eluent is passed through the bed, removing the last traces of uranium, and this is returned to the first eluent tank ready for use next time. At the end of stage 6 the resin bed is full of second eluent, consequently stage 7 consists of a water displacement of the second eluent to first. The elution of *C* is complete, so that in stage 8 the column is on stand-by until column *A* becomes saturated, when it is eluted and *BC* are run on absorption.

It will be obvious from the foregoing that the time for elution of one column must be less than the time for absorption.

Four-column system

The cycle described above is the original one, but in the light of experience and other special considerations, modifications have been developed.

Where a rich ore is being treated, leading to high values of uranium in the pregnant liquor, it may be found that the absorption time is shorter than the elution period. To overcome this difficulty, a four-column plant is used, with two columns on parallel elution.

A typical installation of two sets of four-column plants is to be found at the South Australian Mines Department uranium treatment plant at Port Pirie, South Australia, where ore concentrates from Radium Hill are treated chemically.

It will become apparent to the reader that the process of absorption and elution is a fairly complicated one to operate manually. Consequently these plants have been developed as fully automatic equipment. The operator's main function is to carry out a simple check test to determine when a column requires elution.

Resin in pulp

One main difficulty with the ion-exchange process described above is that the pregnant liquor must be crystal clear before passage through the resin. Now, unfortunately, acid-leached uranium ores are generally very difficult to filter, so that attention has been given recently to the design of equipment which will, by ion exchange, extract the uranium from the unfiltered leach liquor. A system of this sort is known as a resin-in-pulp system.

One such method, already in use in the United States, is the Winchester basket process. In this the resin is contained in stainless-steel wire baskets which are jigged up and down in the leach pulp contained in a series of tanks. It is carried out on a countercurrent basis and, following absorption, the resin is eluted by a similar method in another portion of the plant.

Although in theory this system has much to offer, it presents a certain number of practical difficulties. Whereas leaching is normally carried out at about 60% solids of a grind 60%–200, the basket process only works on a 7% solids pulp all of which is –325. This means that, although filters or other clarification equipment are omitted, the plant needs in their place some fairly extensive desanding equipment.

Another system, which has been developed by Swinton and Weiss for the C.S.I.R.O. in Australia, employs the system of a pulsated bed. The resin is contained in a cylinder with fresh resin being fed at the top and loaded resin being withdrawn at the bottom. The leach pulp is fed at the bottom and the barren pulp overflows from the top, the plant thus running countercurrent. Whilst running, the column is subjected to a pulse which allows the pulp to pass through the resin and prevents it filtering out.

The loaded resin withdrawn from the absorption column is washed to remove all traces of pulp and then eluted in another countercurrent unit. The uranium-rich eluate is precipitated in the normal manner whilst the stripped resin is returned to the top of the absorption column.

In both of these resin-in-pulp type of plants a much coarser grade of ion-exchange resin is used.

Uranium metal purification

The concentrate obtained from a mill is treated at a plant such as that at Springfields to obtain the pure metal.

Ion exchange is not used during this process to purify the metal further, but large volumes of demineralised water are used at different points. In particular, after solvent extraction the solvent is washed with large excesses of water to recover the pure uranyl nitrate in aqueous solution.

Conventional, two-bed-type demineralising gives a high enough quality of water, although, if required, there would be no problem in improving this to mixed-bed grade.

Nuclear reactors

Water treatment was the original use of ion exchange (softening by sodium/calcium exchange). Later its use expanded as better cation exchangers were developed and, when anion exchangers joined those available for industrial plants, demineralisation became possible. Although water treatment for nuclear reactors is very varied, the majority fall within the range of conventional methods.

The line of demarcation is whether or not the water to be treated contains radioactive constituents. Waters that do not, form the greater volume and are used in external cooling circuits and as make-up for the boiler feed water.

Cooling waters need to be non-corrosive and non-scale-forming. Scaling is due to the presence of temporary hardness which is precipitated on heating. Originally this was removed by lime in a precipitation-type softener:

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$$

but is now more easily removed by passage through a weak group cation resin:

$$2R.COOH + Ca(HCO_3)_2 \rightarrow (RCOO)_2\,Ca + 2H_2O.CO_2$$

The water is then passed through a degasifier, thus removing all but a trace of carbon dioxide, and the *p*H adjusted with caustic soda.

Treatment of make-up water for boiler feed will depend on boiler pressure and design. It may consist of simple softening for low pressures using a sodium form cation-exchange resin or any of the many variations through to complete removal of dissolved solids, including silica and carbon dioxide by the mono-bed-type treatment.

Of water that can become contaminated there is the cooling water in the reactor circuits, which will only be of low level, and the cooling water in the reactor proper which may, through fuel element failure, reach a high level of activity. It is, of course, the corrosion products that require removal. Both types are run on closed circuit.

In the former a regeneratable mixed bed is installed in a loop circuit; the flow through it and hence the purity in the main circuit is controlled by test. When this unit is regenerated the waste liquors will contain some activity and must be treated accordingly.

In the second case a non-regeneratable mixed bed is used. The corrosion products consist of suspended impurities, mainly Fe_3O_4 and ferrous hydroxide and dissolved ions such as manganese, nickel, cobalt, sodium, chloride, sulphate, etc. The suspended matter can be removed by filters, but this presents certain difficulties and whilst ion-exchange beds are not designed as such, they do act as extremely efficient filters. Since it is the top portion of the bed that will act as a filter and this is the first portion to become completely exhausted, little or no loss of capacity will result in the omission of any other design of filter.

This type of plant acts as a concentrator for the activity, consequently it must be suitably screened. When the resin it contains becomes exhausted, it is removed and treated as a solid waste material. The cylinder is recharged with fresh resin and put back into service.

Separation of hafnium from zirconium

In nature, zirconium occurs in association with about 1.5 to 2% of hafnium. Because it has a low neutron cross-section and is non-corrosive, zirconium can be used for cans for uranium in reactors. However, hafnium has a high neutron cross-section, so that it is desirable to free the zirconium from as much hafnium as possible. An ion-exchange process has been developed using a strong group cation resin to separate the two metals. Better than 98% of the zirconium is recovered and the quantity of hafnium is reduced to less than 0.01%.

Use is made of the fact that if an acid solution of the zirconium is passed through the cation resin in the hydrogen form, both the zirconium and hafnium are taken up. When the resin is eluted with normal sulphuric acid, the eluate shows two definite bands very distinct and widely separated. The eluate collected from the first band contains the zirconium, whilst the second band will contain some of the hafnium. The rest of the hafnium can be removed from the resin by eluting with a complexing agent.

Waste disposal

Hospitals and chemical laboratories using radioactive tracers will have large volumes of waste water at low levels of activity. Much of these wastes are metallic and, provided that these are not complexed, they can be taken up by cation resins in the sodium or hydrogen form. In the latter case the effluent from them then needs neutralising, since it will be acidic, all the anion radicles present having been converted to their equivalent acid by the exchange of hydrogen for the metals originally present.

Isotopes used include such metals as barium, strontium, zirconium, colombium and rare earths. These are particularly harmful as they concentrate in the body or, alternatively, if effluent containing them is discharged, they have a tendency to precipitate and concentrate along river and canal banks.

Complete demineralisation by either mono-bed or two-bed plants gives a far greater degree of decontamination. Since the ion exchange plant acts as a concentrator for the activity, it may be necessary to screen the units. It is normal not to regenerate the resin but either to dispose of it as a solid contaminated material or incinerate it, thus concentrating the activity even further.

As the ion-exchange units will collect all ions passed through them, it is important to keep the quantity of non-radioactive ions low.

In normal water treatment it is necessary to have clean liquid for treatment with no suspended matter, oil, fat, etc. This may be difficult in the case of waste liquors which can contain all the normal drain wastes including such things as soaps and detergents. However, if the resin bed is to be used but once, the decrease in capacity will be only very slight and the fact that the liquid being treated is not clean can be ignored.

Rubber-metal De-bonding

With increased demand for components in which rubber is bonded to metal a need to salvage metal parts has also become important. The claim is made that, of the available methods of de-bonding, the destruction of the bond by heat has the virtues of simplicity, universal application and rapidity of action. In order to eliminate the disadvantages inherent in the combustion method, a process has been developed which is based on the principle of destructive distillation in a closed vessel in the absence of air.

A de-bonding plant of this type has been in operation at the factory of a well-known rubber company in the London area for some months, and is giving every satisfaction in the reclamation of metal parts.

The charge of components weighing 10 to 15 cwt. is loaded into a container and thence into a vertical cylindrical retort, the cover of which is sealed down. A gas-fired furnace provides the heat necessary to distil the rubber, the process taking approximately seven hours, during which the temperature is not allowed to exceed 500°C. The products of distillation are gaseous, liquid and solid; the two former being separated by cooling the hot vapours leaving the retort, whilst the solid product is a carbonaceous residue left in the container.

The metal parts remaining in the container are easily cleaned by a relatively mild barrel tumbling process, the carbon residue being quite acceptable for disposal by the normal method.

The new process has been developed by W. C. Holmes & Co. Ltd.

Recent Publications

Smoke density. A recent illustrated pamphlet from Radiovisor Parent Ltd., Stanhope Works, High Path, London, S.W.19, describes the type RV2 and SA56 units in the company's range of photo-electric smoke density indicators.

Fine grinding. Follsain-Wycliffe Foundries Ltd., Lutterworth, nr. Rugby, have published a detailed booklet about *Pulmac* mills for fine grinding. It includes full particulars of the size and capacity of the mills, the materials that can be handled and their maximum sizes and adds instructions on installation and operating.

Cellulose derivative. A water-soluble cellulose derivative (sodium carboxymethyl cellulose) known as *Courlose* and produced by Courtaulds Ltd., Coventry, is the subject of a small booklet published by the company.

Asbestos. A 16-page illustrated brochure on *Caposite* amosite asbestos moulded thermal insulation materials (blocks and pipe sections) and complementary materials is the latest in the series of technical sales literature on the products of the Cape Asbestos Co. Ltd., 114 and 116 Park Street, London, W.1.

Ceramics. William Boulton Ltd., Burslem, Stoke-on-Trent, have published a 64-page, fully illustrated catalogue of their equipment for the pottery, chemical and process industries, in addition to a number of leaflets setting forth technical details about individual items of equipment.

Tanks and tubes. The summer edition of the house magazine of W. P. Butterfield Ltd., Shipley, Yorks., contains, as well as items of general interest, a description of three spirit-blending tanks manufactured to a customer's special requirements, some information about irradiation hood tubes and liners produced for the U.K.A.E.A. and the fourth in a series of articles on stainless-steel processing techniques.

Materials handling. In connection with a recruiting drive aimed at doubling its present membership, the Institute of Materials Handling, 20-21 Took's Court, Cursitor Street, London, E.C.4, has prepared a 28-page booklet to give all the background information that anyone unfamiliar with the work of the Institute might be likely to require. Besides setting out all the rules, the structure and the aims of the Institute, it defines materials handling and deals with the function of the materials handling specialist.

Raw Materials for Detergents

ENGINEERING FEATURES OF SHELL HAVEN PLANT

THE growth of the synthetic detergent industry has been one of the outstanding features of the industrial scene in Britain since the second world war. At first the industry had to rely on the United States for its raw materials, but in 1948 Shell started up a plant at Curaçao in the Caribbean for the manufacture of propylene tetramer detergent alkylate and in 1949 Monsanto's new plant at Newport (Mon.) came into the picture. This was the only U.K. source of detergent alkylate until, early in 1956, Grange Chemicals brought into production their £1 million plant at Grangemouth, Scotland, with an output of something over 10,000 tons p.a.

In July last year, the Shell Chemical Co.'s detergent alkylate plant at Shell Haven, with an annual capacity of 30,000 tons, came on stream, and some details of this plant are given below.

Neat layout

The plant was built for Shell Chemical Co. Ltd. by Foster Wheeler Ltd. of London from designs based on Shell's experience with the Curaçao plant and the pilot plant in the Netherlands. It occupies a total surface area of about 8 acres and the layout follows logically from the sequence of the process steps. The tank farm, the pump house, the reaction and distillation sections are placed in rectangular plots parallel to each other. The central control room, offices for supervising staff and a small laboratory are adjacent to the reaction and distillation sections.

The reaction involved is a modification of the well-known Friedel-Craft one, an aromatic hydrocarbon (benzene) being alkylated with an olefin (tetrapropylene) in the presence of an acid catalyst. The product is largely mono-alkyl benzene although some di-alkylation does occur.

Process sequence

In the reaction section benzene and the olefin stream are fed through the feed drier and circulated with the catalyst through the reactor vessel, baffled for effective mixing. Careful control of the conditions such as residence time, benzene-olefin ratio and the amount of catalyst is maintained. The reaction is exothermic and cooling facilities are included.

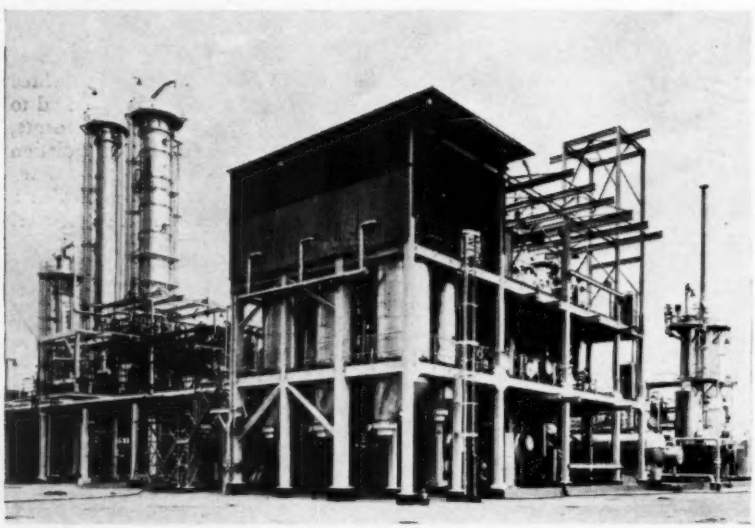
Most of the catalyst is separated by gravity from the crude alkyl benzene in a settler, and recycled. Residual catalyst and some excess benzene are removed by passing the product through a stripper and chemical treaters. The hydrocarbon mixture is then passed to the distillation section of the plant for further purification.

The distillation section consists of three columns. In the first column the remaining benzene is stripped off and recycled, in the second an unwanted low-boiling fraction is removed overhead, and in the third, pure alkyl benzene is removed overhead. The heavy residual bottoms from the final column are removed for other uses.

Safety and control arrangements

A small regeneration column maintains the acid catalyst in a high state of purity and a neutral tar fraction produced is used as fuel for the plant. Due to the nature of the catalyst, strict safety precautions are observed. Protective clothing is supplied to all working on the site and to visitors, and washdown facilities are available. The action of standing under one of the showers automatically starts the shower and operates an alarm signal in the control room.

The operation of the plant is fully automatic, control being effected from a central room equipped with a Honeywell-Brown console control desk. A small laboratory equipped with a Towers automatic recording I.P. distillation apparatus adjoins the control room.

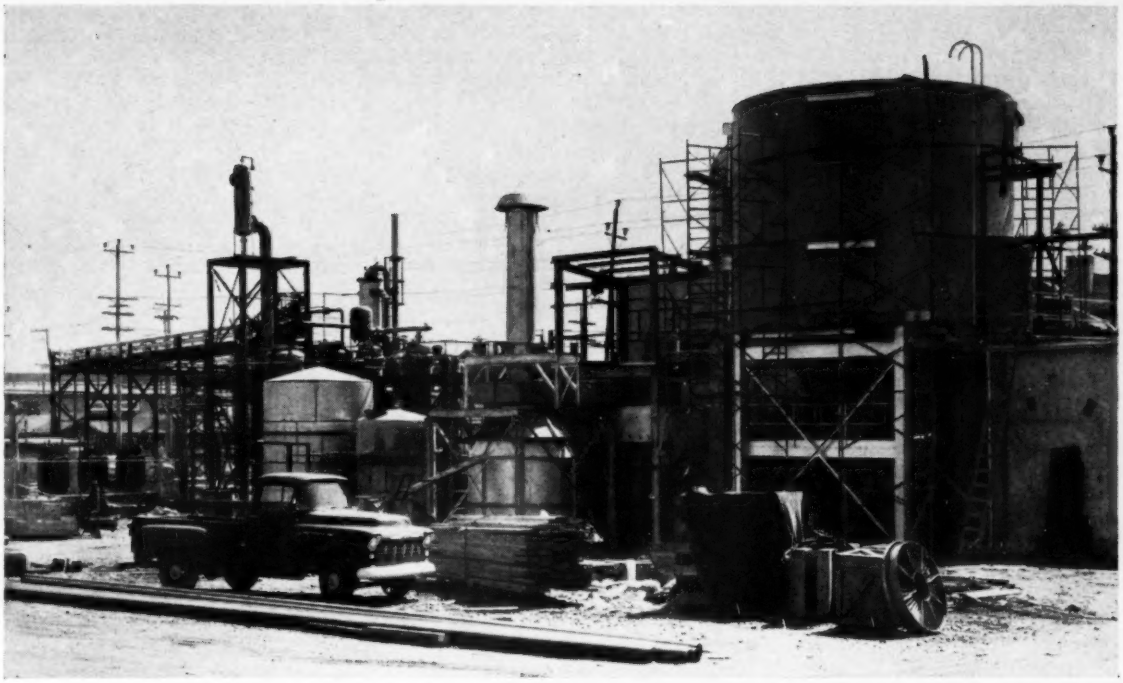


A view of the detergent alkylate plant at Shell Haven, showing the acid catalyst unit, with driers and treaters in foreground.

Nuclear plant progress

'As is well known there are many forms of reactor, but the only type producing power comparable with thermal stations, based on coal and oil fuel, or hydroelectric power stations, is the graphite-moderated, carbon-dioxide-cooled design we are using in this country, with natural uranium as the fuel. For a country to be self-sufficient in producing the enriched fuel needed for other types of reactor, the vast sums and additional power required are likely to make alternative processes entirely uneconomic for some time ahead. Hence there should be a good export field for us.'

These comments were made by Mr. Richard Miles, chairman and managing director of Head, Wrightson & Co., in his annual statement. He had earlier pointed out that the company was deeply interested in nuclear plant in two important directions: Head Wrightson Processes Ltd., in co-operation with the United Kingdom Atomic Energy Authority, are building materials testing reactors and ancillary equipment at home and overseas, while in addition Head Wrightson & Co. are shareholders and participants in the Nuclear Power Plant Co. Ltd. The latter company's first order, for a complete nuclear power station, has been received from the C.E.A. and construction has already begun at Bradwell in Essex.



General view of the new million-dollar ' Rayflo ' plant of Alaska Pine & Cellulose Ltd. nearing completion.

Canada's First 'Silvichemical' Goes into Production

By J. Grindrod

Inaugurated last September, a new $1*-million plant of Alaska Pine & Cellulose Ltd., Canadian subsidiary of the large United States chemical cellulose producer, Rayonier Inc., has been brought into production at Marpole, on the southern outskirts of Vancouver, B.C., for the manufacture of a ' silvichemical ' called* Rayflo, *which will be used in oil drilling operations as a mud dispersant. It is claimed to be the first oilwell drilling dispersant produced in North America under chemically-controlled conditions and replaces extracts of the quebracho tree imported from South America.*

'SILVICHEMICAL' is a term coined by Rayonier three years ago to describe complex tree chemicals other than cellulose. In cellulose production, only about 50% of the tree is recoverable cellulose and Rayonier research has, for some time, been directed toward the utilisation of the residual material. Recognising that these non-cellulose materials have good commercial possibilities, the company maintains a sizeable research unit within its research division devoted exclusively to silvichemistry. Hitherto these interesting and valuable chemicals have been left unused because they were not properly understood. Now it is believed by Rayonier that, by separating and using these chemicals, they are on the threshold of an entirely new and important chemical realm and one which holds high promise for new and useful products.

Rayflo is, indeed, the first of three completely useful laboratory-developed silvichemicals thus far produced on a commercial scale. The other two are being produced at Rayonier's southeast Georgia plant, while other silvichemicals are in various stages of field testing.

Oil-drilling mud development

Chemically produced from the waste material from lumber and pulp operations, *Rayflo* is a reddish-brown powder described as a polymeric polyphenol. In oilwell drilling, use is made of fluids called muds which serve several purposes inasmuch as they lubricate the drilling tool, seal the hole against gas and oil pressure and bring drill cuttings up to the surface. In drilling through certain formations the mud picks up clay. This hydrates and tends to thicken the mud and make it difficult to pump. In shallow wells the mud is thinned

with water, but, as the hole deepens, it becomes necessary to maintain a high-density mud and large quantities of weighting materials are added to keep the mud heavy enough to prevent blowouts. Dilution with water at this stage would be impractical and wasteful and it is, therefore, necessary to use thinners which keep the muds dispersed and fluid enough to be pumped and recirculated. In this connection, *Rayflo*, used as a thinner, is particularly resistant to the adverse effects of such contaminants as cement, salt and gypsum, giving a more stable, and because of this, a more economical and efficient mud.

Readily soluble in water, *Rayflo* does not require the use of caustic soda for dissolving. Also, less caustic soda is required to attain a given level of performance. Experience in the oil fields has shown that *Rayflo*-treated mud has lower viscosity and gel strength at low alkalinity than quebracho-treated mud and, when used in highly alkaline fresh water and lime muds it shows very good properties as a thinner. Furthermore, it facilitates a very smooth breakover when converting a fresh-water mud to a lime mud. It is claimed to be meeting with unusual success in oil-drilling operations in the Texas, California and Venezuelan oil fields and to be finding immediate acceptance in offshore oil-well drilling operations.

Complete utilisation of hemlock trees

Although developed at the research laboratories of Rayonier Inc. at Shelton, Washington, and pilot-produced in a small plant at Grays Harbor, Washington, the new silvichemical is being commercially produced initially only at Marpole, Vancouver, since Canada is in the enviable position of having sufficient raw material to satisfy the mounting demand that is expected for the product. The hemlock bark used for this purpose will be supplied by the Alaska Pine pulp mill alongside.

With the start of production at the new plant, the complete hemlock tree, which 20 years ago was so insignificant in the British Columbia lumber industry that it was not even graded, will be utilised for the first time in the history of the industry. Primarily cut for lumber, the remainder will be chipped for pulp, the sawdust and shavings used to power the steam plant and the bark used for the new silvichemical.

Production and research

Although details of the new plant at Marpole are not available, it is known that *Rayflo* is manufactured under strict chemical control and that a network of six pipelines, comprising 6,000 ft. in all and ranging in size from 1 to 6 in., carry steam, water, chemicals and *Rayflo* liquor *via* an overhead route between an extraction unit and a drying plant, which are situated 1,000 ft. apart in the mill yard.

Dr. E. L. Lovell is the silvichemist in charge of Alaska Pine & Cellulose Ltd.'s research laboratories at Vancouver, B.C., and Dr. K. R. Gray is research supervisor in charge of silvichemical research and development at Rayonier's Olympic research division at Shelton, Washington.

It is understood that some 200 oil men attended meetings at Edmonton and Calgary, Alberta, when the new chemical was introduced.

Supplies of the hemlock raw material are secured by forest management licences granted to the company so long as the latter carries out its responsibilities that go with the licences.

British Standards

Drop point determination (B.S. 2877: 1957, 2s. 6d. net, 'Determination of drop point of petroleum greases'). This is a further document in the series of methods of test for petroleum products which have been developed by the Institute of Petroleum. It contains full details of the apparatus and procedure to be adopted in the determination of the drop point, as well as specifying the temperature to be used.

Viscometry (B.S. 188: 1957, 10s., 'Determination of the viscosity of liquids in c.g.s. units'). First published in 1923 to encourage the expression of viscosity in 'c.g.s. units' rather than in arbitrary units depending on the instrument used, this British Standard has now been revised for the first time since 1937.

As in the previous editions, both capillary viscometers and falling sphere viscometers are described. The classification 'capillary viscometers,' however, now includes suspended-level and reverse-flow types as well as the simple U-tube type. For completeness of treatment, a description of the Cannon-Fenske capillary viscometer, used mainly in America, has been included. The reverse-flow U-tube viscometer is now specified for measurement of the viscosity of opaque liquids; details of the Lee type of viscometer have been omitted.

An important change is that water is now the sole reference liquid, and every capillary viscometer is to be directly or indirectly calibrated against water at 20°C. The method of calibration, using master viscometers and a 'step-up' procedure, is described.

The appendices to the standard deal with various corrections and ancillary apparatus and with the use of air pressure for extending the application of capillary viscometers to liquids which show non-Newtonian behaviour.

Welding aluminium (B.S. 1126: 1957, 3s. net, 'General requirements for the gas welding of wrought aluminium and aluminium alloys'). This revised standard—in which details of weld preparation have been specified for the first time—includes a number of new features, including a section devoted to information required by the welding organisation and a table which relates the various grades of parent metal to recommended filler rods. Since inadequate flux removal may cause a weld to corrode, details of satisfactory flux removal have been included as an appendix to the standard. Another appendix contains concise recommendations for working the weld metal.

Flameproof enclosure of electrical apparatus (B.S. 229: 1957, 7s. 6d. net). A revised edition of what is, in effect, the key specification for the enclosure of electrical apparatus for use in situations where flammable or explosive gases or vapours may be present, this standard includes the results of research on the method of assessing the statistical maximum safe-gap for the gases and vapours and a more precise method of grouping than that of the 1946 edition of the standard has been evolved. Requirements in Group II for the sleeve bearings of large rotating machines for gases and vapours have been changed to make the construction and operation of the apparatus more practicable.

Heat-exchanger tubes (B.S. 1464: 1957, 4s. net, 'Solid-drawn copper alloy tubes for heat-exchange equipment in the petroleum industry'). This revised standard specifies requirements for the following alloys: aluminium brass; Admiralty brass; 7% aluminium bronze (copper aluminium); 70/30 brass; and 70/30 copper nickel.

Company News

Monsanto Chemicals Ltd. are developing the pattern of their internal organisation to meet the requirements of the continued growth of their business and their current programme of expansion. Operations are now divided between two new divisions, respectively called the chemicals division and plastics division. This decentralisation will increase the efficiency of customer and after-sales service and enable still greater attention to be given to production, research and technical matters.

The directors of the chemicals and plastics divisions will carry overall responsibility for all operations in their respective divisions, including the co-ordination of production and engineering, sales, research and personnel. The main products handled by the chemicals division will be heavy and fine chemicals. The main products handled by the plastics division will be plastics, rubber chemicals, oil additives and other technical chemicals.

The wholly owned subsidiary, Monsanto Plastics Ltd., will cease to function in view of the change to divisional organisation. Sales of styrene plastics are now the responsibility of the plastics division.

*

Follsain-Wycliffe Foundries Ltd. have appointed two new representatives. Mr. W. A. Murray, 147 Bath Street, Glasgow, C.2, has been appointed representative for Scotland. Messrs. Barrett, Greene & Co. Ltd., Walton, Stone, Staffs., have been appointed as representatives in north Wales, the Potteries, Shropshire and south Cheshire.

*

A change of name and the formation of a new subsidiary company are announced by Taylor-Short & Mason Ltd., who explain that as the company's business fell into two clearly defined categories they have undertaken a reorganisation which they feel will give better service to customers and will increase efficiency. A new subsidiary company has been formed which revives the original name, Short & Mason Ltd., and this will handle the scientific and meteorological instrument business which has been associated with the name Short & Mason for the last 92 years.

To avoid any confusion in the future the name of the main company has been changed from Taylor-Short & Mason Ltd. to Taylor Controls Ltd., and this company, Taylor Controls Ltd., will continue to handle all industrial instrument and control business which is so closely associated with the American design of instruments manufactured by Taylor Instrument Companies, Rochester, N.Y., U.S.A., under the trade mark *Taylor*.

Short & Mason Ltd., under the managing directorship of Mr. E. J. Jordan, is being moved to a newly acquired factory about a mile from the existing plant. The address of this new subsidiary company will be Aneroid Works, 280 Wood Street, Walthamstow, London, E.17 (telephone: Coppermill 2203 and 2204).

Taylor Controls Ltd. (formerly Taylor-Short & Mason Ltd.) remains under the same management and in the same works, which is being renamed Forest Works, at 75 Hale End Road, Walthamstow, London, E.17 (telephone: Larkswood 3371 to 3376 inclusive).

*

The new headquarters of the sales department of William H. Capper & Co. Ltd. is at Mayfair House, 9 Hertford Street, London, W.1. The company announced that the opening of this new office was due to expanding sales of fabricated pipework, chemical valves and pumps, and increasing demand for their erection services. The company's premises at 1 and 3 Elliott's Place, Colebrooke Row, London, N.1, are being retained as the site of the London works and headquarters of the Capper Pipe Service & Welding Co. Ltd., a subsidiary company concerned with contracts involving erection.

*

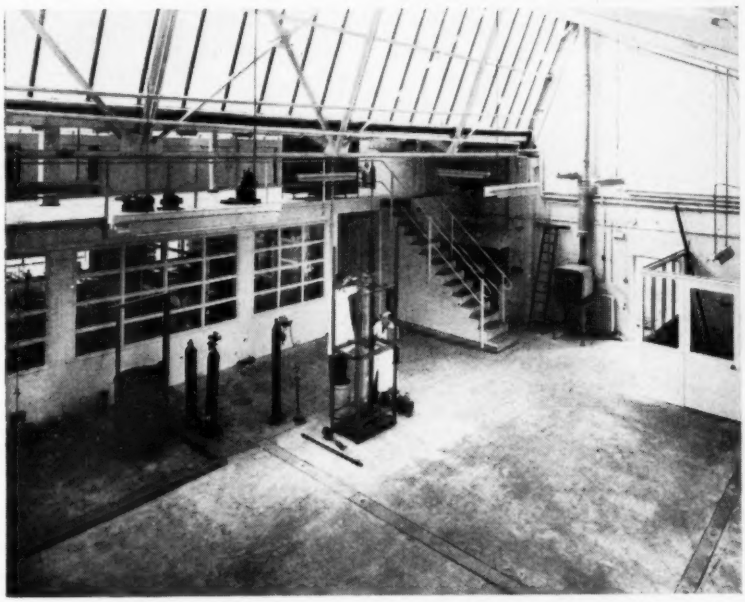
Gas purification and developments in catalytic oil gas making are important items in the programme to be followed in a laboratory opened by Humphreys & Glasgow Ltd. at Billericay, Essex. Work on other new methods of gas making will also be carried out, together with short-term investigations arising from the company's entry into the chemical process field.

The building is designed so as to provide the necessary space, height and services for tests not only on the laboratory scale, but also with larger apparatus.

The main building also houses a plant for processing and treatment of catalyst for the company's *Onia-Gegi* oil gas process.

CPE COST INDICES —LATEST FIGURES

Here are the two latest figures to be added to our cost indices (June 1949 = 100): Plant Construction Cost Index, June, **169.7;** Equipment Cost Index, June, **160.6.**



Humphreys & Glasgow's new laboratory at Billericay, Essex.

Personal Paragraphs

★ Monsanto Chemicals Ltd. have made a number of new appointments in connection with the changes in their internal organisation mentioned in our 'Company News' columns this month. **Mr. D. R. Mackie** has been appointed director of the chemicals division in addition to his duties as managing director. **Dr. J. W. Barrett** has been appointed director of the plastics division in addition to his duties as technical director. In addition, **Mr. N. F. Patterson,** previously operations director, now becomes director of production and engineering with additional overall responsibility for purchasing department and, through **Mr. S. E. Chaloner,** labour relations. **Dr. W. H. Garrett** becomes personnel director responsible for industrial relations and general personnel policy. **Mr. D. C. M. Salt** has been appointed general manager of sales of the chemicals division and **Mr. J. S. Hunter** has been appointed general manager of sales of the plastics division.

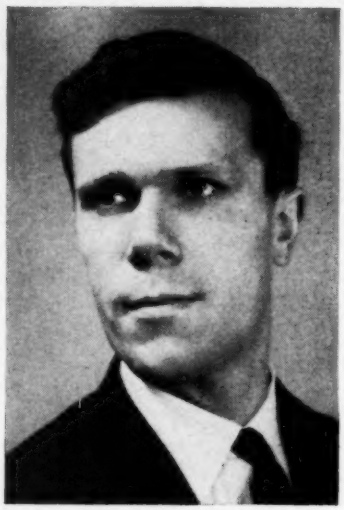
★ The Plessey Co. Ltd. have announced that **Mr. P. W. Faulkner,** O.B.E., general manager of the chemical and metallurgical division, Towcester, Northants, has been appointed an executive director of the company.

★ Sharples Chemical & Industrial Ltd. have announced the appointment of **Dr. A. J. Hayter** as a director of the company.

★ Sharples Centrifuges Ltd. have announced the following new appointments: **Mr. W. Maxfield** has been appointed senior project engineer (Scotland and Northern Ireland) and **Mr. R. S. Curwen** has been appointed senior project engineer (south-east England). **Mr. F. V. Hooley** has joined the head office applications engineering staff at Camberley and will be principally concerned with Sharples' interests in the field of vegetable refining, soap manufacturing and the foodstuffs industry.

★ The death has been announced of **Mr. L. K. Brindley,** consultant to the president of the International Nickel Co. of Canada Ltd., who at his retirement last February was deputy chairman of the Mond Nickel Co. Ltd.

★ **Mr. D. S. Momand,** chairman and managing director of Miles Laboratories Ltd. and its subsidiary companies, has retired as managing director, but continues as chairman of the board of Miles Laboratories Ltd. **Mr. W. Morgan Thompson,** formerly a director of Monsanto Chemicals Ltd., succeeds Mr. Momand as chief executive of the Miles companies in Great Britain and has been appointed managing director of Miles Laboratories Ltd. and chairman of the boards of the subsidiary companies, Ames Co. (London) Ltd. and Don S. Momand Ltd.



Dr. A. J. Hayter

★ **Dr. W. E. Hanford** has been appointed assistant to the president for research at Olin Mathieson Chemical Corporation. He had been vice-president and director of the M. W. Kellogg Co.

★ British Oxygen Chemicals Ltd. have appointed two new directors. They are **Mr. L. G. D. Sheldrake,** who is appointed works director, and **Mr. J. M. Williams,** who becomes sales director. The appointments were effective from July 1.

★ **Mr. M. L. Hobday,** former general manager of the Tasman Pulp & Paper Co. Ltd., has been appointed general manager of the Whakatane Board Mills Ltd., succeeding Mr. E. Brown, who recently died. Mr. Hobday, who is an Englishman, took up his appointment with the Tasman company in 1953. He resigned over a year ago.

★ **Dr. Om. P. Kharbanda** has been appointed technical assistant to the director and general manager (India) of Simon-Carves Ltd. He will be located at Calcutta, India.

★ **Mr. V. D. MacLachlan,** sales director and general manager of Honeywell-Brown Ltd., has completed 20 years' service with the company and at a special dinner party **Mr. E. C. Vorlander,** managing director of the company, recalled that when Mr. MacLachlan first joined the company its instrumentation business was handled from one small office in London, whereas today ten fully equipped branch offices are in operation.

Mr. V. D. MacLachlan, sales director and general manager, celebrates the 20th anniversary of his appointment to Honeywell-Brown Ltd. With him are *(right)* **Mr. E. C. Vorlander, managing director, and** *(left)* **Mr. O. B. Wilson, vice-president of the company's associates in Philadelphia, U.S.**

Technology Notebook

Scientific and technological training in South Africa

Successive South African Governments had failed badly in providing facilities for the training of professional chemists and other scientists, said Dr. S. S. Israelstam, a past president of the South African Chemical Institute and senior lecturer in the department of chemistry and chemical engineering at Witwatersrand University.

He said Russia was far ahead of Western countries in the training of scientists, technologists and technicians. Britain and the United States were making efforts to rectify this, but South Africa had done little in this direction. The universities had not been provided with enough money to employ sufficient lecturers to train the scientists that South Africa required.

Dr. Israelstam was able to announce, however, that the Department of Education, Arts and Science had decided to introduce a chemical technicians' diploma. A good deal of the initiative for this had come from the South African Chemical Institute. The next step was for the Government to concern themselves with the problem of making good the scarcity of scientists. In this regard they welcomed the formation of the scientific advisory committee which was to advise the Cabinet on scientific policy.

First woman president for R.I.C. (New Zealand)

Dr. Elsa Beatrice Kidson, of the Cawthron Institute, Nelson, becomes the first woman in New Zealand to be elected as president of the Royal Institute of Chemistry (New Zealand branch).

Sandwich course in chemical engineering

With the ending of the first complete session of its sandwich course in chemical engineering, established with 12 students as a works-based scheme in 1957, the West Ham College of Technology reports that the scheme has proved attractive to both industry and student alike, carrying as it does exemption from the Associate-Membership examinations of the Institution of Chemical Engineers.

However, considerable resistance to a works-based scheme has been encountered, and present indications are that several likely applicants who could easily be accommodated at the college will have to be rejected for lack of sponsoring firms. The principal of the college states that there appears to be no single reason for the apparent apathy on the part of industry. In some cases the new sandwich course conflicts with existing apprentice schemes; in others a works-based course is unacceptable; and yet, it is pointed out, on every hand there is evidence of a grave shortage of chemical engineers for some years to come.

U.S. research grant for Aslib

Mr. Leslie Wilson, director of Aslib, has announced the award of £10,000 by the U.S. National Science Foundation to Aslib for research into the comparative efficiency of various indexing and information retrieval systems. The research programme, which is expected to take two years to complete, is to be conducted at the College of Aeronautics, Cranfield, and will be under the control of Mr. C. W. Cleverdon, librarian of the college.

Isotopes in industry

The isotope school at Harwell is arranging a three-day course from September 25 to 27, 1957, for directors and senior executives from industry to enable them to hear about and discuss the limitless uses to which radioisotopes can be put.

Elemental boron

Borax Consolidated Ltd. are marketing crystalline elemental boron in the pure state (99 to 99.7%) which is expected to be of great interest to the electrical and metallurgical industries.

In December 1955, the company announced pilot-scale production of two grades of amorphous elemental boron, one in 90 to 92% and the other in 95 to 97% purity and, since then, they have been working towards the production of the pure element.

The new product is far more inert than the finely divided amorphous material and has a low oxygen and nitrogen content, making it particularly suitable for incorporation into alloys.

Ethics of interviewing

During the meeting of the American Society for Engineering Education in June, 1956, the Engineering College Administrative Council of the Society, the Committee on Ethics, and doubtless other units within the Society considered irregularities and abuses which had developed in the recruitment of seniors for engineering industries. In the meantime, the Midwest College Placement Association had formulated a code for interviewing. This code was reviewed by the Committee on Ethics of A.S.E.E. The two organisations co-operated and were able to produce a set of regulations acceptable to both.

Corrosion symposia

Accelerated testing of rust preventives, experience with liquid metal corrosion and corrosion in the corn wet-milling industry are among the topics to be covered in the chemical processing industries symposium at a meeting of North Central Region, National Association of Corrosion Engineers, to be held in Chicago from October 1 to 4, 1957. The meeting will include eight symposia and a full day of technical committee meetings.

Fifth World Petroleum Congress

The Fifth World Petroleum Congress is to be held in the Coliseum, New York City, in early June 1959, and the various categories of new information to be presented for discussion by oil technologists were considered at a recent meeting in Germany which was presided over by Mr. E. V. Murphree, chairman of the council and president of Esso Research & Engineering Co.

Institute of Metals meeting

At the invitation of the Scottish local section, the 1957 autumn meeting of the Institute of Metals will be held in Scotland from September 16 to 20. The meeting will be centred on Glasgow, but a day will also be spent in the Edinburgh area.

Synthetic rubber testing

Goodrich, Goodyear and Firestone are reported to be testing new types of man-made rubber which imitate natural's high heat resistance. Officials say this is the key to final independence from plantation rubber, which still holds a third of the U.S. market.

Technicians now claim they can make the new material at prices competitive with crude rubber's New York rate of about 33 cents/lb. However, it is still more costly than the 23-cent factory tag for ordinary synthetic.

Production of the new heat-resistant types is still in the pilot stage, but some commercial output may start in two or three years. Despite the new developments, rubber men admit that complete U.S. dependence on synthetics is still years away.

World News

WESTERN GERMANY

Man-made fibre plant for Rumania

It is reported from Frankfurt that the first Rumanian plant for the production of man-made fibres is now being built under the direction and with the co-operation of the Hans J. Zimmer Co., which is acting as consulting engineer, at Piatra Neamt, in the Moldavia area.

The plant is set up under the Rumanian programme to extend the production of consumer goods. Total costs amount to DM50 million. The German firm will receive DM25 million for working out the blueprints, control of the construction work, assembling the plant and putting it into operation. It also has arranged for the supply of the electric equipment and the instruction of the Rumanian workers.

The plant, which is expected to start production in the second half of 1958, is planned to have a daily capacity of 7,000 kg. of lactam, which will be produced on the basis of phenol.

INDIA

Aluminium

It is planned to set up an aluminium plant in Mettur, Madras, if it should prove economical to extract the metal from bauxite ore available in the Shevroy hills.

The production of aluminium in India reached a record figure during 1955-56. Production during 1955 was 7,225 tons. Figure for the first half of 1956 was 3,449 tons.

The annual consumption of aluminium in India has been estimated at 35,000 tons by the end of 1958. The total consumption of metal in India during 1955 was 22,765 tons.

Copper sulphate production

The Travancore Chemical & Manufacturing Co. Ltd. have commissioned a new plant at Alwaye, Kerala, for the production of 3,000 tons p.a. of copper sulphate, which is expected to meet India's total need for this fungicide. The plant is expected later to produce other fungicides such as copper oxychloride and cuprous oxide.

Lignite

The U.K. firm, Powell Duffryn Technical Services Ltd., have been appointed technical advisers on the mining section of the Neyveli lignite project. It is planned to generate power by mid-1960, produce fertilisers by the end of 1960 and manufacture briquettes by October 1961.

NORWAY

Titanium

The experiments undertaken by Titan A/S have arrived at a process by which the iron content of the titanium ore mined in the Jössingfjord district can be extracted, producing at the same time concentrated titanium of high oxide content. The ore at present exported from this district contains 44% titanium oxide and 35% iron. In 1957 the export of ore is expected to reach 200,000 tons or 12% of the total world production.

HUNGARY

Plastics projects

Nearly half of the 137-mile Rumanian section of pipeline which will carry methane gas to Hungary for the plastics industry has now been laid down, according to a recent report. It was expected that the last delivery of pipes to the Rumanian section would take place by next spring. Work on the 83-mile Hungarian section would start this year.

The pipe will carry 200 million cu.m. p.a. of gas from just outside Bucharest to Tiszapalkonya, north-east Hungary, where the chemical combine which will turn it into raw material for the plastics industry is semi-completed. The materials are required mainly for making PVC and PAN (polyacrylonitrile), the latter better known as *Orlon*.

It was also announced that this year would see the completion of the new section of the Hungaria chemical works which will produce basic material for the manufacture of *Perlon* artificial threads. At the Viscosa works at Nyergesujfalu a new section was being built to produce 300 tons p.a. of *Perlon* drawn thread. Production should begin in mid-1958.

Building of a works to produce 200 lb./day of polythene was near completion, according to the report.

AUSTRALIA

Sulphuric acid plant

The sulphuric acid plant at Shell's Geelong refinery will be completed before the end of 1958 at a cost of some £500,000, the chairman of the Shell Group in Australia, Mr. J. R. C. Taylor, has announced.

Most of the acid from this plant will be supplied under a long-term contract to the neighbouring works of Cresco Fertilisers Ltd., who will use it for making superphosphate. Cresco also expect to have some acid available for sale to industry.

This arrangement, in conjunction with Cresco, represents the latest move towards the fulfilment of the Government-sponsored programme of reducing Australia's dependence on imported sulphur for sulphuric acid manufacture. The potential saving by the operation of the new plant is £250,000 p.a.

GREAT BRITAIN

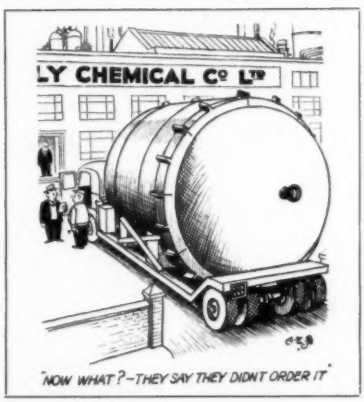
Peaceful uses of atomic energy

The British Government have accepted an invitation from the Secretary-General of the United Nations to participate in a second International Conference on the Peaceful Uses of Atomic Energy, to be held in Geneva in 1958 from September 1 to 13, inclusive. The last conference, in 1955, occurred at a time when a great deal of work previously held classified by the U.K., America and Canada was released for publication, and the same will be true of the next one, since further important fields of work have recently been declassified.

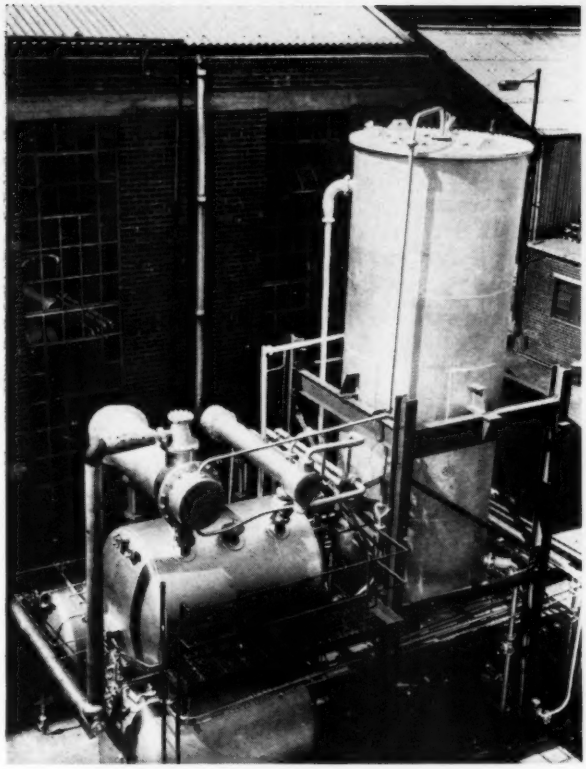
Industrial safety

'Guard Your Hands' is the slogan for this year's nation-wide campaign which the Royal Society for the Prevention of Accidents is organising with the object of reducing the number of accidents in industry. Each year the Society organises a Safety Week during which special attention is directed to the reduction of industrial accidents generally, or to a particular aspect of the problem—care of the eyes and feet are examples of previous campaigns.

As with previous campaigns, this one will be directed mainly at manage-



"NOW WHAT?—THEY SAY THEY DIDN'T ORDER IT"



NEW CHEMICAL PLANT IN YORKSHIRE

A new processing plant has recently been erected at the Castleford (Yorks.) works of Hickson & Welch Ltd. The picture shows new equipment used in the synthesis of an organic intermediate used widely in the preparation of a pharmaceutical product. The plant was designed and built by the company's own staff.

ments, who during the week will be asked to do everything possible to encourage their employees to work safely—and particularly to look after their hands.

UNITED STATES

Sulphuric acid plant

W. R. Grace & Co. has announced that its Davison chemical division will build in Casper, Wyoming, a $2-million plant to produce sulphuric acid. The plant will have a daily capacity of 200 tons of 100% sulphuric.

Gulf Oil enter benzene field

Gulf Oil Corporation has announced its intention to enter the field of benzene production with construction to begin this summer of a large benzene plant at its Port Arthur, Texas, refinery, capable of producing approximately 30 million gal. p.a. When the plant is completed, late in 1958, Gulf will become one of the leading suppliers of this important chemical raw material.

Feedstocks for the planned benzene plant will be drawn from Port Arthur refinery streams, and the finished product is expected to be the highest-quality benzene commercially available. The plant also is expected to produce substantial amounts of toluene.

JAPAN

Synthetic rubber industry

The Government approved the presentation of a draft bill to the Diet whereby a joint state/private company would be established to develop the production of synthetic rubber in Japan. Capital would amount to 2,500 million yen, of which 1,000 million would be subscribed by the Government, which would further make available 5,700 million yen in Development Bank Loans as part of the proposed company's operating funds, estimated at some 14,000 million yen. The projected production capacity is 400,000 tons of ordinary synthetic rubber and 5,000 tons of latex p.a. by 1962.

MEXICO

Polythene and chemical plants

It is reported that Pemex have signed a contract for the construction of a Phillips process polythene plant at Azcapotzalco. It is also reported that contracts have been signed for the construction of a carbon disulphide and a dodecyl benzene plant and for three catalytic crackers; all of these orders are said to have gone to U.S. contractors.

SOUTH AFRICA

Nitrogen manufacturing capacity increased

African Explosives & Chemical Industries announced recently that it is starting a large expansion of its nitrogen manufacturing capacity at Modderfontein dynamite factory near Johannesburg. Expenditure on the project is estimated at £10 million.

The scheme includes the extension of ammonia output by 70,000 tons p.a. and the installation of plant to convert nearly the whole of this additional output into about 110,000 tons p.a. of urea—a high nitrogen content fertiliser.

Chemical industry development

In his presidential address to the 11th annual convention of the South African Chemical Institute, Dr. Frank Hawke said in Durban that the chemical industry in the Union was developing at a greater rate than in most other countries. One of the contributory factors was the phenomenal growth of the uranium industry in the Union. Concurrently with the demand for better-trained chemists has come the demand for more chemists. The majority of chemists are employed in industry, and industry today is expanding rapidly, he said.

FRANCE

Butyl synthetic rubber output

The Societe de Caoutchouc Butyl (Socabu) reports that its butyl synthetic rubber plant now under construction at Port Jerome, near Le Havre, will go into production in the second half of 1958. Initial output will be at the rate of 20,000 tons p.a.

It is claimed that this plant is the first of its kind built outside the United States. Its production will meet French butyl rubber needs, while a small surplus will also be available for export.

CHILE

Nitrate outlook

The President of the Anglo Lautaro Co. stated during a visit that the future outlook for nitrate was good, as modern processes are much more

efficient than the old Shanks processing system which only uses minerals with a 15% nitrate content as against 7%. Plans are being studied to set up a chemical industry based upon the by-products of the new process. Several small plants using the Shanks system have requested permission to shut down, as they are unable to operate at a profit.

SPAIN

Potassium salts exploitation

The National Institute of Industry (N.I.I.) is to erect a factory for the exploitation of potassium salts in Navarre with a production of 200,000 tons p.a. of anhydrous potassium oxide and a textile factory in Malaga with an initial capacity of 200,000 spindles.

BURMA

Manufacture of basic chemicals

A private Burmese company, Electro-Chemical Industries and Trading Co. Ltd., has been formed to manufacture basic chemicals. The main portion of this enterprise will be a plant to manufacture caustic soda and its by-products, chlorine gas, hydrochloric acid and bleaching powder.

MEETINGS

Institute of Petroleum

October 2. 'Modern Trends in Petroleum Analysis,' by H. Powell and W. H. Thomas, and 'Modern Trends in the Instrumentation of Refinery Processes,' by S. W. J. Wallis and D. S. Townend, 5.30 p.m., 26 Portland Place, London, W.1.

Incorporated Plant Engineers

September 12. 'The Design and Application of Rotary and Reciprocating Air Compressors,' by W. Scott, 7.15 p.m., Scottish Building Centre, Glasgow.

September 17. 'Titanium as a Material of Construction in the Chemical Industry,' by K. W. J. Bowen, 7.30 p.m., Hotel Leofric, Coventry.

INTERNATIONAL CONFERENCES

September 9-12. Third World Congress on Chemical Fertilisers, Heidelberg, Germany.

September 15-20. International Conference on Co-ordination Chemistry, Rome, Italy.

September 24-26. Conference on Industrial Carbon and Graphite, London.

October 3. Congress—European Federation of Chemical Engineering, Zürich, Switzerland.

The Leonard Hill Technical Group—September

Articles appearing in some of our associate journals this month include:

Atomics—Fuel Element Re-processing; Power from Nuclear Fusion; Niobium as a Nuclear Metal; A New Radiation Monitor; Dounreay's Fast Reactor; Television at Calder Hall.

Paint Manufacture—Automation in the Paint Industry; Formulating with Chlorinated Rubber; Modern Trends in the British Printing Ink Industry, 2; Testing Furniture Finishes; Paint and Lacquer Additives, 4; Silicones in Protective Coatings; The Storage Stability of Polyvinyl Acetate Emulsion Paints.

Dairy Engineering—Instrumentation of Milk Evaporation Systems; Electronic Instruments in the Dairy Industry; The Dairy Industry in South-East Asia; Dairy Products in Collapsible Metal Tubes; Gyratory Vibration in Cheesemaking Process.

Automation Progress—Automatic Assembly in the U.S.A.; Control of Quality in Automatic Production; Transfer Pressing; Production Engineers Hear About Change and Control; Getting Information into a Computor; A Modern Semi-Automatic Plating Shop.

World Crops—Economic Species, Varieties and Forms of Coffee; Food and Farming in Japan; The Deep-Litter System in the Tropics.

Building Materials—Silicone Water Repellents for Masonry; Vikon Metal Tile; Insulated Sandwich Walls; Porc-lin-ply.

Food Manufacture—Animal Feeds; Leaf Protein as a Human Food; Pea Canning in the Western U.S.A.; Nisin and its Uses in Food Technology; Food Research: An American Panorama; Extra Facilities for Baking Research; Floors.

Petroleum—Synthesis of Liquid Fuels in China; The Yorktown Refinery; Routine Inspection of Petroleum Process Plant; Daura Refinery Extensions; The Oil Geology of Australasia.

Manufacturing Chemist—Pumps and Pumping; Review of Pumps for the Process Industries; Colgate's Operations in Manchester; The Synthesis of 2-Deoxy-D-Ribose; Progress Reports.

Corrosion Technology—Cathodic Protection of Bare Buried Pipeline; Cathodic Protection of Underground Refinery Equipment; Wetting Agents in Metal Treatment; It's Got Corrosion Taped; Corrosion Research Laboratories, 13.

Polymerisation reactor

In our August issue, page 343, we published a photograph of a polymerisation reactor made and designed by Metal Propellers Ltd. Allspeeds Ltd., who supplied us with the information for the caption, now wish us to point out that the reactor was made to the order of Esso Research Ltd. and not Shell Ltd. as was stated.

INDUSTRY REPORTS...

Plastics plant expansion

With the formation of a new company, Formica Ltd., in Britain, to be jointly owned by American Cyanamid Co. and Thomas De La Rue & Co. Ltd. (as announced in CHEMICAL & PROCESS ENGINEERING last month), De La Rue are erecting new buildings in Tynemouth for the expansion of their laminated products *Formica* and *Delaron*. This was stated by the chairman of the company at the recent annual general meeting.

Power stations and research

John Thompson Water Tube Boilers Ltd. satisfactorily completed in 1956 a number of contracts for power stations both in Britain and overseas. It is undertaking a large part of the work for the Berkeley power station. The chairman reminded shareholders in his circulated statement that this nuclear power work is, to some extent, a substitution for conventionally fired power stations, which will inevitably reduce in number with the development of atomic power stations.

During 1956 the new John Thompson research building came into use.

Britain's economic plight

The importance of exports to the national economy was stressed by Mr. W. H. Higginbotham, chairman of Edgar Allen & Co. Ltd., during some comments on the economic situation at the end of his review of the company's affairs. On inflation, he said that the nation had been living—not beyond its means, but beyond its own willingness to provide those means—and must now face the consequences.

The company showed a new record in the total value of sales, and increased trading profits. The influx of new orders was reported to be very satisfactory. In the engineering section, deliveries on the large contract for cement-making plant for Iran (of nearly £1 million) will make a substantial addition to turnover.

More nickel for world's use

A forecast that in 1961 there will be over 75% more nickel available for civilian use than was the case in 1956 was made by the chairman of International Nickel Company of Canada Ltd., Dr. J. F. Thompson, in a letter to shareholders. This was assuming that defence demand remains at its present level and that nickel is not taken in 1961 for government stockpiling.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

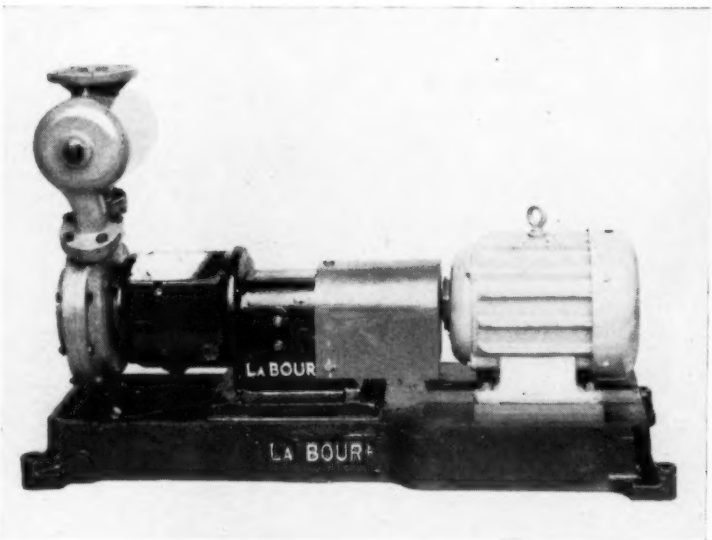
Pumps with mechanical seals

Pumps exhibited by the British LaBour Pump Co. Ltd. at the Engineering, Marine, Welding and Nuclear Energy Exhibition include, for the first time, certain models fitted with mechanical seals of various manufactures.

Types UHL/UPL are presented with new bearing and impeller assemblies, while types DZT and Q represent the LaBour open-impeller design for flooded suction pumps. Type UZ, with a *Vulcoferran* lining and a special mechanical seal arrangement, is a new development intended particularly for handling HCl, ferric chloride solutions etc. where the use of metals or alloys is prohibited either because of their unsuitability or high cost.

Type BG is a development of the LaBour type G, a vertical pump outstanding by virtue of its operation without packed-gland mechanical seal; this is a pump particularly applicable to handling dangerous/corrosive liquors where approach for maintenance must be reduced to an absolute minimum.

Type SGHL, developed in conjunction with the user, and shown for the first time, is LaBour's 'vacuum extraction duty' pump; specifically developed for use with evaporator, vacuum filter, condenser installations etc., the SGHL can be so arranged as to draw liquor from vessels under vacuum equivalent to 28 in. of mercury, and is available in the full range of LaBour's corrosion-resistant alloys where appropriate; the design incorporates a seal bath whenever the gland is fully immersed at all times, so preventing the entry of air when running under vacuum conditions. **CPE 711**



Type SGHL vacuum extraction pump

Full-bore flow valves

A range of *Stufline* valves for pressures up to 100 p.s.i. has been introduced by Dewrance & Co. Ltd. These valves are claimed to give good service in controlling 'stuff' to the beaters in paper mills and wood-pulp mills and in chemical industries for the control of thick liquids and wet grain. They are full-bore, unrestricted-flow valves and are simple and economical in construction, seldom requiring attention. The valves are easily inserted into the pipeline and are secured between the pipe flanges by anchor bolts or studs. They are supplied with cast-iron bodies and valve plate, with bronze spindle. As an alternative the valve plate can be in stainless steel, bronze or copper. Made in sizes 4 to 18 in. **CPE 712**

Versatile bellows

Made from highly finished, cold-rolled, stainless-steel sheet of uniform thickness, butt-welded bellows produced by the bellows division of Teddington Aircraft Controls Ltd. can be used for exhaust connections, expansion or offset joints—in fact,

C.P.E.'S MONTHLY REPORT AND READER SERVICE

wherever a corrosion- or temperature-resistant flexible connection is required. Sizes are from ¾ to 84 in. internal diam., although dimensions larger than this can be made to special order.

One application of the range of bellows specially produced for use in the nuclear energy field is the main ducts which carry hot CO_2 gases from the atomic pile to the heat exchanger. This requires hinged bellows units designed for $\pm 1°$ of angulation at 250 p.s.i. working pressure and 400°C. and made from titanium-stabilised 18/8 stainless steel.

A further application involves the use of bellows on handling machines and/or stand pipes, where thermal expansion causes variation in the position of their end connection. Flexible bellows pieces enable any such discrepancies to be taken up.

CPE 713

Foam branchpipe

Particularly effective for the application of foam in large quantities to highly inflammable fire risks of all kinds, a new, portable foam branchpipe has an operating pressure of 60 p.s.i., at which pressure it passes 100 gal./min. of foam solution. Its foam-expansion ratio is 10: 1 and under favourable conditions expansion ratios of the order of 13: 1 can be obtained. With a water pressure of 100 p.s.i. this foam branchpipe is capable of delivering 1,500 gal./min. of foam. The Pyrene Co. Ltd. are the makers.

CPE 714

Scale-free heating

Efficient production today demands the elimination of scale formation in high-temperature heating processes. That demand, it is claimed, is met by the *Equiverse* system, devised by the Incandescent Heat Co. Ltd., and recently demonstrated by the Gas Council.

The system incorporates a novel thermal cycle which can be applied to existing or new furnaces, static or continuous, large or small, and covering all heating jobs from 750 to over 1,300°C.

Some of the features of the system are: automatic atmosphere control to maintain reducing conditions in the furnace; preheating of combustion air to ensure easy attainment of working temperatures; completion of combustion by the introduction of secondary air into the flue gases; and recirculation of the flue gases to increase their velocity through the regenerators and so improve the heat-transfer coefficient.

Metallic elements in the regenerators with a large surface area compared with total weight afford rapid and uniform pre-heat of the combustion air when using short reversing cycles.

CPE 715

NEW CALCIUM SILICATE

Joseph Crosfield & Sons Ltd. launch *Microcal*, their new calcium silicate, this month. This material is one of a group of products which together comprise 'silica fillers'—chemicals which are finding increasing preference in such industries as rubber and paper. It is offered to the paper trade as an economical opacifying and brightening filler, while it is produced by methods which give it maximum reinforcing properties when compounded with natural or synthetic rubber. **CPE 716**

Differential-pressure meter

Sunvic Controls Ltd. are to manufacture under licence in Britain the differential-pressure meter developed by the Barton Instrument Corporation, of California. Using two mechanically linked, liquid-filled bellows, this instrument provides rotation of a torque tube which corresponds to changes in applied differential pressure. The torque arm can be coupled to a pressure transmitter to provide an output of 3 to 15 p.s.i., it can also be linked mechanically to an indicating gauge or recorder.

The instrument has a body of either cast or stainless steel, pressure-rated to 2,500 p.s.i. The differential overload rating is the same as the static-pressure rating. Selection of a low-freezing-point liquid for the bellows filling allows the instrument to be used in temperatures down to −25°F.; recommended maximum temperature for continuous duty is 200°F.

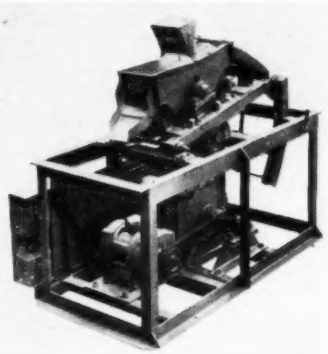
CPE 718

WORK GLOVES

These new Plastic-Dot *industrial work gloves produced by Tedson, Thornley & Co. Ltd. have plastic dots permanently fixed to the cloth, which are claimed to give a good gripping surface and to provide longer wear. The gloves feel as soft and comfortable as cotton gloves and are made in men's and women's sizes.* **CPE 717**

Pneumatic jig

Separation of coarse material in the dry state, such as in the recovery of metallic fragments from industrial wastes, the grading of light and heavy peas or the scalping of impurities in chemical manufacture, are a few of the applications of a new pneumatic jig, now being produced by Knapp & Bates Ltd.



'Vibrair' jig

Construction and operation of this machine are simple, the operating principle involved being that an air 'cushion' is created above a vibrating, inclined plate. Due to specific gravity differences in material being treated, light particles, being more easily airborne, are carried down the plate and heavy particles ride up the plate, due to their more frequent contact with the vibratory motion.

In construction, the machine consists of a sloping trough, coupled to a windbox which receives air from a fan. The air emerges from the windbox through a porous, sintered phosphor-bronze plate which forms the trough bed. Vibration of the trough is effected by a high-speed, low-

amplitude eccentric, this motion being adjustable by varying the speed of the eccentric and by adjusting four toggles which hold the trough in position. A control for the fan motor is included to provide regulation of the air volume passing through the sintered plate. **CPE 719**

Manifold valve

A unit suitable for the many applications where air pressure requires to be regulated and controlled is the $\frac{3}{4}$-in. B.S.P. manifold valve SF 1169 manufactured by Lang Pneumatic Ltd.

This manifold, housed in a gun-metal body, incorporates a pressure-reducing valve operated by a large synthetic-rubber diaphragm giving extreme sensitivity, stop valves on both high-pressure inlet and low-pressure outlets, a needle valve to give fine regulation of flow, a non-return valve

Manifold valve

to offset any dangerous consequences for the operator in the event of an air failure, and a 3-in.-diam. pressure gauge graduated 0 to 160 p.s.i.

The unit is designed for ease of mounting and maintenance, and can be used for many applications, such as power presses, clutches, brakes etc. It is ideal for multi-station control from one location. **CPE 720**

Degassing aluminium

Degassing of aluminium and its alloys during foundry operations is claimed to be simplified by the introduction of the *Foseco Degaser* 400, a new tablet produced by Foundry Services Ltd. With this degassing tablet the reaction is controlled, so that a much smaller bubble size is formed and this permits greater dispersion, which frees the melt of harmful gases that ultimately lead to porous castings. Test cases confirm that *Degaser* 400 can produce aluminium melts of such low hydrogen content that in even the heaviest cast sections the danger of pinhole porosity due to absorbed gases is eliminated. **CPE 721**

IMPROVED CENTRIFUGE

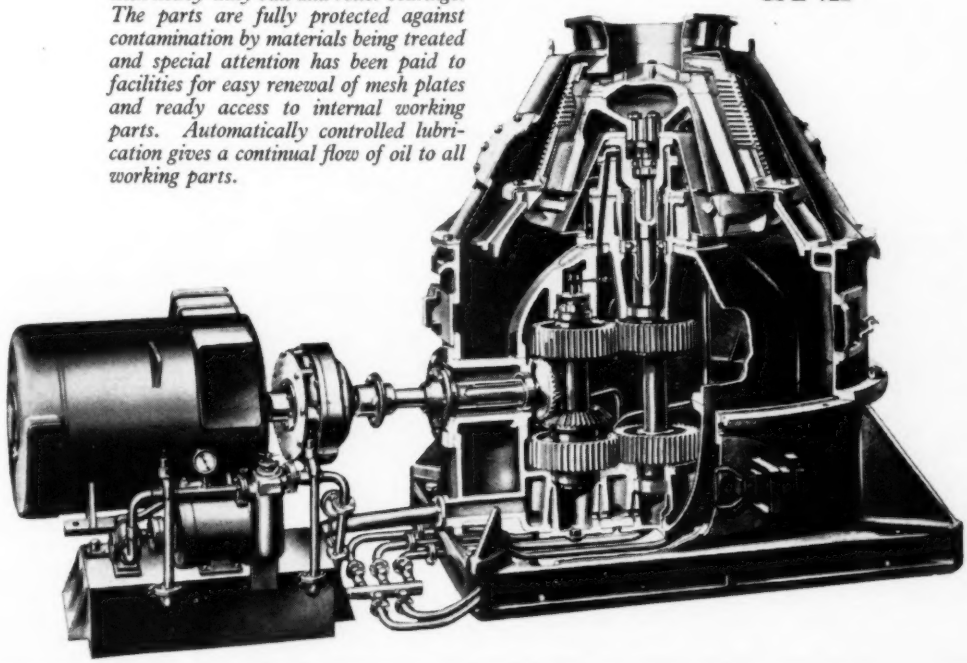
Head Wrightson Colliery Engineering Ltd., of Sheffield, a subsidiary of Head Wrightson & Co. Ltd., announce that work has been completed on an improved design of centrifuge of special interest to the coking and gas-making industry.

The centrifuge occupies a space of approximately 6 ft. cube and the gear assemblies are made of special alloy steel with heavy-duty ball and roller bearings. The parts are fully protected against contamination by materials being treated and special attention has been paid to facilities for easy renewal of mesh plates and ready access to internal working parts. Automatically controlled lubrication gives a continual flow of oil to all working parts.

This equipment is designed to decrease the free moisture contained in various materials of comparatively small size by the use of centrifugal force and the moisture contained in washed small coal and slurry can be reduced to between 6 and 7%.

The capacity of the standard size varies from 50 to 80 tons/hr. and the power absorbed is approximately 45 h.p.

CPE 722



Flame detector in gas chromatography

The Shandon Scientific Co. Ltd. flame chromatograph for gas chromatography has been designed as a highly sensitive, selective and rapid method of analysis. This is claimed to be the only commercially available apparatus where detection is achieved by the simple method of burning the exit gases at the end of a chromatographic column in a micro-flame and continuously monitoring its temperature.

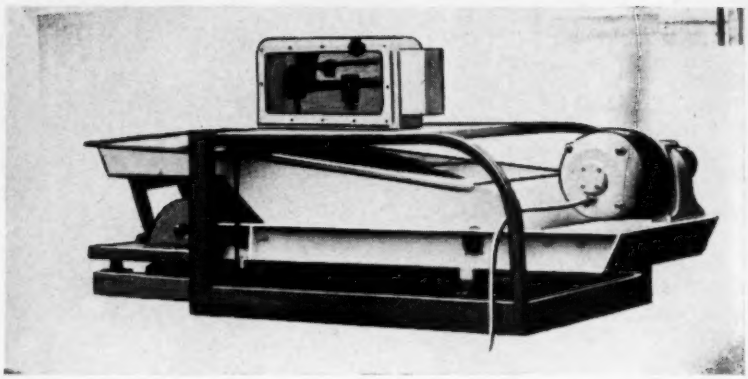
The Shandon flame chromatograph has been designed on the unit principle to make the equipment as flexible as possible and capable of dealing with a great variety of work; up to four analysers can be operated from the central unit. **CPE 723**

Gravimetric feeder

The gravimetric or constant-weight feeder is employed in industrial installations particularly where a number of materials have to be continuously discharged at exact rates before mixing together to form a single product, also to feed a machine at a perfectly constant rate and for large-scale batching when the feeder can be controlled by a time switch.

The *Magco* constant-weight feeder, made by the Magnetic Equipment Co. Ltd., comprises a vibratory feeder of controlled output discharging into a pivoted conveyor, the feed falling on to the belt at the end remote from the pivot ensures that the turning moment is at a maximum giving a sensitivity far higher than is possible with similar machines in which the complete conveyor is suspended from a scale.

The conveyor is driven by a constant-speed motor, except in the case of remote-control machines where the drive is by an electronically controlled variable-speed motor. The conveyor is counterbalanced by a steelyard in a dust-tight case; for manual-control machines adjustment of discharge is by moving the steelyard weights, for remote control the belt speed is varied. It should be noted that there is no mechanical connection between the steelyard and control, electronic control giving the highest accuracy. **CPE 724**



Gravimetric feeder shown enclosed for dusty and dangerous materials

Take your laboratory with you

Small-scale interchangeable jointed laboratory apparatus, when first introduced a few years ago, was christened the 'vest-pocket laboratory' for organic preparation and analysis. Quickfit & Quartz Ltd. are now marketing a condensed verson of this equipment which will really go into a briefcase, if not into a waistcoat pocket.

Twenty small components which are packed into a strong box measuring 11 × 9 × 2¾ in. and weighing 3 lb., can be speedily assembled in various combinations.

No less than a dozen different assemblies of apparatus can be built up, for filtration, separation, reflux and distillation with or without stirring or vacuum.

The box not only provides protection in transit without the need for troublesome packing material, but serves permanently for storage. It opens out to form a stand on which the apparatus can be assembled without the need for any additional clamps and supports. **CPE 727**

Elements for specialised applications

Precision resistive elements, developed from a special moulded carbon technique are suitable for many industrial applications such as movement indication and control, liquid-level control and remote indication, continuous rotation potentiometers, high-speed switching, stepped attenuators, strain gauges etc. The makers are the Plessey Co. Ltd. **CPE 725**

PURE WATER FROM SEA WATER

Richardsons, Westgarth & Co. Ltd. have developed an entirely new type of distilling plant producing pure water from sea water. The plant design is based on an exhaustive series of tests conducted under industrial operating conditions on large-size test rigs, using sea water. Operating methods have been developed, permitting the plant to be run continuously without being opened for cleaning and without loss of output due to scaling. Designs for outputs up to 1 million gal./day (4,500 tons/day) in one unit are available.

An order recently received for a unit of this type is for installation in a refinery in Ecuador. Considerable further business is expected in this field, particularly for export, in view of the growing demand for fresh water in a number of arid territories. **CPE 726**

Laminated PVC ducting

Laminated PVC ducting is available including solid PVC exhaust ducts, bends, tee pieces, offset pieces, weather caps and deflector caps. Using these prefabricated sections, it is claimed, any heating and ventilating engineer with only an elementary knowledge of plastic welding can erect a corrosion-free fume ducting system. According to the suppliers, Horwitch Smith & Co. Ltd., the grade of PVC used gives strength equal to light metal and at the same time is light in weight. **CPE 728**